Rock River Water Reclamation District
Rockford, Illinois

Bidding Requirements and Contract Forms

for

Main Pump Building HVAC Upgrades

Capital Project No. 2002
Rock River Water Reclamation District
Rockford, Illinois

Bidding Requirements and Contract Forms
and
General Provisions and Technical Specifications
for
Sanitary Sewer Construction

for

Main Pump Building HVAC Upgrades

Capital Project No. 2002

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TABLE OF CONTENTS

Rock River Water Reclamation District
Rockford, Illinois
Main Pump Building HVAC Upgrades
Capital Project No. 2002

I. Bidding Requirements
   Article 1 Notice to Bidders
   Article 2 Instructions to Bidders
      1 General
      2 Legal Requirements
      3 General Instructions
   Article 3 Technical Specifications

II. Contract Forms
   Proposal
   Affidavit of Compliance
   Bid Bond
   Agreement
   Performance Bond
   Labor & Payment Bond

III. EJCDC C-700 General Conditions and Supplementary Conditions

Section I

Bidding Requirements
Article 1 — Notice to Bidders

The Rock River Water Reclamation District (District) will receive sealed and signed bids for the Main Pump HVAC Upgrades, Capital Project No. 2002, at the District office located at 3501 Kishwaukee Street, Rockford, Illinois until 1:00 p.m. on Thursday, January 16, 2019 at which time and place responsive / responsible bids will be publicly opened and read aloud.

The Main Pump Building HVAC Upgrade project consists of installing new roof along with the replacement of skylights, roof hatch, and rooftop exhaust fans. The project also includes removal and replacement of an outdoor air supply fan, outdoor air intake dampers and ductwork. A new direct digital controls and fire alarm system will also be installed. The project will also include the refurbishing of two (2) air handling units, the replacement of lighting, and replacement of existing gas detection system in the Main Pump Building.

Bidder’s attention is called to Article 2 – Instructions to Bidders 3.8 requirements for Statement of Qualifications. Bidder must have a permanent business office within forty (40) miles of the District office at 3501 Kishwaukee Street in Rockford, IL.

Substantial completion (all HVAC equipment installed and fully functional) shall be September 16, 2020. Final completion shall be October 30, 2020. Liquidated damages shall be $300.00 per each consecutive calendar day for each completion date.

Bid documents may be obtained at a cost of $50.00 per set (non-fundable) by contacting the District Engineering Department at 815.387.7660.

Plans and specifications may also be viewed at the offices of the Northern Illinois Building Contractors Association at 1111 S. Alpine Rd, Rockford, IL. For more information, visit the District website at www.rrwrd.dst.il.us.

All construction will be done in accordance with specifications on file with the District, including the General Provisions and Technical Specifications for Sanitary Sewer Construction (Current Edition) by the Rock River Water Reclamation District of Rockford.

Each proposal must be accompanied by the District Bid Bond form with an acceptable Bid Security attached, in the amount of five percent (5%) of the total bid price. This amount is a guarantee that, if the Proposal is accepted, a contract will be entered into and its performance properly secured.

A Mandatory Pre-Bid Meeting for this project will be held on Monday, December 23, 2019 at 2:00 p.m. in the District’s Board Room, 3501 Kishwaukee Street, Rockford, Illinois. All contractors that intend to bid on this project must attend the pre-bid meeting.

The successful bidder will be required to furnish a satisfactory performance bond in the full amount of the bid or proposal. No bid shall be withdrawn without the consent of the District for a period of sixty (60) days after the scheduled time of receiving bids.

The District reserves the right to reject any or all bids, or any part thereof, or to accept any bid or any part thereof, or to waive any formalities in any bids, deemed to be in the best interest of the District.

Dated this 16th day of December, 2019.

BY: Chris Black, Director of Finance
Article 2 — Instructions to Bidders

1 General

1.1 Scope and Intent

This section of the contract documents is concerned with furnishing detailed information and requirements for preparing bids to prospective bidders, bidders' responsibility, the preparation and the submission of bids, basis for awarding the contract and other general information concerned with bidding and executing the contract.

1.2 Contradictions

If in the case of apparent contradiction between or among the Contract Documents, the Contract Documents shall be consulted in the following order: Addenda, Agreement, Supplementary Drawings, Instructions to Bidders, Detailed Specifications, Plans, District General Provisions and Technical Specifications for Sanitary Sewer Construction. The language in the first such document in which language regarding the conflict, error or discrepancy occurs shall control.

1.3 Mandatory Pre-bid Meeting

A Mandatory Pre-Bid Meeting for this project will be held on Monday, December 23, 2019 at 2:00 p.m. in the District’s Board Room, 3501 Kishwaukee Street, Rockford, Illinois. All contractors that intend to bid on this project must attend the pre-bid meeting.

2 Legal Requirements

2.1 Illinois Regulations

1. The undersigned, as Bidder, declares he will comply with prevailing wages in accordance with the Illinois Department of Labor Standards. The State of Illinois requires contractors and subcontractors on public works projects (including Rock River Water Reclamation District) to submit certified payroll records on a monthly basis, along with a statement affirming that such records are true and accurate, that the wages paid to each worker are not less than the required prevailing rate and that the contractor is aware that filing false records is a Class B Misdemeanor.

   The certified payroll records must include the name, address, telephone number, social security number, job classification, hourly wages paid in each pay period, the number of hours worked each day, and the starting and ending time of work each day, for every worker employed on the project. Any contractor who fails to submit a certified payroll or knowingly files a false certified payroll is guilty of a Class B Misdemeanor. Certified payroll reports shall be submitted on standard IDOT forms.

2. Public Act 83–1030 entitled "Steel Products Procurement Act" requires that steel products used or supplied in performance of this contract or subcontract shall be manufactured or produced in the United States with three exceptions.

   The provisions of this Section shall not apply:

   a. Where the contract involves an expenditure of less than $500.

   b. Where the executive head of the public agency certifies in writing that

      i. the specified products are not manufactured or produced in the United States in sufficient quantities to meet the agency's requirements, or

      ii. obtaining the specified products, manufactured or produced in the United States would increase the cost of the contract by more than 10%.

   c. When its application is not in the public interest.
3. Public Act 96-929 (30 ILCS 570) provides that Illinois residents be employed on Illinois public works projects, provided there has been a period of excessive unemployment (5%) in the State of Illinois as defined in the Act; and, further, that Illinois workers are available and capable of performing the particular type work involved.

4. Public Act 99-0933 requires that any party to a contract adopt and promulgate written sexual harassment policies that include, as a minimum, the following information:
   a. the illegality of sexual harassment
   b. the definition of sexual harassment under Illinois State law
   c. a description of sexual harassment, utilizing examples
   d. my (our) organization's internal complaint process including penalties
   e. the legal recourse, investigative and complaint process available through the Illinois Department of Human Rights and the Illinois Human Rights Commission
   f. directions on how to contact the Department and the Commission
   g. protection against retaliation as provided by Section 6-101 of the Illinois Human Rights Act

   Upon request, this information shall be provided to the Illinois Department of Human Rights and the District.

5. With regard to nondiscrimination in employment, the Contractor for this project will be required to comply with the Illinois Fair Employment Practices Commission's Rules and Regulations.

6. The Contractor for this project shall comply with the Occupational Safety and Health Act.

7. The Contractor for this project shall comply with the Federal Drug-Free Workplace Act.

8. Public Act 96-1416 requires the Certification of Clean Construction and Demolition Debris (CCDD) and uncontaminated soil prior to disposal at a CCDD fill site. The Contractor for this project shall comply with Public Act 96-1416 and be responsible for the certifications and any fees associated with the disposal at a CCDD fill site.

   a. In the event that contaminated soil is uncovered on the project, the Contractor shall notify the District immediately. Any extra costs resulting from the presence of contaminated soil shall be evaluated in accordance with District General Provisions & Technical Specs for Sanitary Sewer Construction; General Conditions: Article 5 – Time Provisions and Article 8 – Changes.

2.2 Americans with Disabilities Act

The Contractor for this project will comply with all applicable requirements of the Americans with Disabilities Act of 1990 (ADA). The Contractor will hold harmless and indemnify Rock River Water Reclamation District (District) and their representatives from all:

1. suits, claims, or actions
2. costs, either for defense (including but not limited to reasonable attorney's fees and expert witness fees) or for settlement
3. damages of any kind (including but not limited to actual, punitive, and compensatory damages)
relating in any way to or arising out of the ADA, to which said firm is exposed or which it incurs in the execution of the contract.
3 General Instructions

3.1 Bidder's Responsibility
Bidder's are cautioned not to submit proposals until having carefully examined the entire site of the proposed work and adjacent premises and the various means of approach and access to the site, and having made all necessary investigations to inform themselves thoroughly as to the facilities for delivering, placing and handling the materials at the site, and having informed themselves thoroughly as to all difficulties involved in the completion of all the work under this Contract in accordance with its requirements.

Bidders must examine the Plans, Specifications and other Contract Documents and shall exercise their own judgment as to the nature and amount of the whole of the work to be done and for the bid prices must assume all risk of variance, by whomsoever made, in any computation or statement of amount or quantities necessary to complete fully the work in strict compliance with the Contract Documents.

The Bidder must satisfy himself by making borings or test pits, or by such methods as he may prefer, as to the character and location of the materials to be encountered or work to be performed. No pleas of ignorance of conditions that exist or that may hereafter exist, or of conditions or difficulties that may be encountered in the execution of the work under this Contract, as a result of failure to make the necessary examinations and investigations, will be accepted as an excuse for any failure or omission on the part of the Contractor to fulfill, in every detail, all of the requirements of the Contract Documents, or will be accepted as a basis for any claims whatsoever for extra compensation or for an extension of time.

The Contractor is responsible for verifying the location of all existing utilities in the project areas.

The Bidder, therefore, shall satisfy himself by such means as he may deem proper as to the location of all structures that may be encountered in construction of the work.

3.2 Addenda and Interpretations
No interpretation of the meaning of the Plans, Specifications, or other Contract Documents will be made to any bidder orally. Every request for such interpretation must be in writing addressed to the Rock River Water Reclamation District, 3501 Kishwaukee Street, Rockford, Illinois. To be given consideration, such request must be received at least five (5) days prior to the date fixed for the opening of bids. Any and all such interpretations and any supplemental instructions will be in the form of written addenda which, if issued, will be sent by email, fax, or certified mail with acknowledgement of receipt requested, to all prospective bidders, at the respective addresses furnished for such purposes, not later than three (3) days prior to the date fixed for the opening of bids. Failure of any bidder to receive any such addenda or interpretation shall not relieve said bidder from any obligation under his bid as submitted. All addenda so issued shall become part of the Contract Documents.

3.3 Laws and Regulations
The prospective bidder is warned that he must comply with all laws of the United States Government, State of Illinois, all ordinances and regulations of the District in the performance of the work under this contract. The Bidder's attention is specifically called to that provision of the General Conditions regarding the rate of wage to be paid on the work.

3.4 Form, Preparation, and Presentation of Proposals
For particulars as to the quantity and quality of the supplies, materials and equipment to be furnished, and the nature and extent of the work or labor to be done, prospective bidders are referred to the Contract Documents, which may be examined or obtained at the office of the District.
Each bid will be submitted upon the prescribed proposal form. The blank space for the total amount lump sum bid, expressed in figures, for providing all materials, equipment, warranty, and labor to complete this project in conformity with all specifications price must be filled in, in ink. If the proposal contains any omissions, erasures, alterations, additions or items not called for in the proposal, or contains irregularities of any kind, such may constitute sufficient cause for rejection of bid. In no case is the agreement form to be filled out or signed by the bidder.

The bid must be verified and be presented on the prescribed form in a sealed envelope on or before the time and at the place stated in the Advertisement for Bids, endorsed with the name of the person, firm or corporation presenting it, the date of presentation, and the title of the work for which the bid is made. If forwarded by mail, the sealed envelope containing the proposal and marked as directed above, must be enclosed in another envelope addressed to Clerk of the Rock River Water Reclamation District, 3501 Kishwaukee Street, Rockford, Illinois, 61109 and be sent preferably by certified mail. The District will not accept facsimile generated bids.

3.5 Bid Security
Each proposal must be accompanied by the District Bid Bond form with an acceptable Bid Security attached, in the amount specified in Article One, Notice to Bidders. This sum is a guarantee that, if the Proposal is accepted, a contract will be entered into and its performance properly secured. The District’s Bid Bond Form included in the bid packet must be used. No other bid bond form may be substituted.

Within ten (10) days after the opening of bids, the deposits of all but the three lowest bidders will be returned. The deposits of the remaining two (2) unsuccessful bidders will be returned within three (3) days after the execution of the contract, or, if no such contract has been executed, within sixty (60) days after the date of opening bids. The deposit of the successful bidder will be returned only after he has duly executed the contract and furnished the required bond and insurance.

3.6 Affidavit of Compliance
Each proposal must be accompanied by an executed Affidavit of Compliance. A separate Affidavit of Compliance form is enclosed with the Proposal packet. Failure to submit an executed Affidavit of Compliance with the proposal may constitute sufficient cause for rejection of the bid.

3.7 Statement of Qualifications
Each proposal must be accompanied by a Statement of Qualifications certifying that the bidder is registered to do business in the State of Illinois, has a permanent business office within forty (40) miles of the District office at 3501 Kishwaukee Street in Rockford, IL, and provides documentation that the bidder possesses the appropriate financial, material, equipment, facility and personnel resources and expertise necessary to meet all contractual obligations. The bidder shall document no less than three (3) contracts for sanitary sewer system within the past five (5) years having equal or greater value to the bid being submitted. The District reserves the right to request additional information as needed to evaluate bids prior to making an award.

3.8 Comparison of Proposals
Bids on lump sum contracts will be considered upon the basis of the lowest sum bid.

3.9 Acceptance of Bids and Basis of Award
No bidder may withdraw his bid after the scheduled closing time for receipt of bids, for at least sixty (60) days.

The contract will be awarded, if at all, to the lowest responsive, responsible bidder. The District also reserves the right to reject any or all bids.
The bidder whose proposal is accepted shall enter into a written contract for the performance of the work and furnish the required bonds and insurance certificate within ten (10) days after written notice by the District’s Director of Engineering has been served on such bidder personally or by mailing a postpaid wrapper to such bidder at the address given in his proposal. If the bidder to whom the contract is awarded refuses or neglects to execute it or fails to furnish the required bond and insurance within five (5) days after receipt by him of the notice, the amount of his deposit shall be forfeited and shall be retained by the District as liquidated damage and not as a penalty. It being now agreed that said sum is a fair estimate of the amount of damages that the District will sustain in case said bidder fails to enter into a contract and furnish the required bond and insurance. No plea of mistake in the bid shall be available to the bidder for the recovery of his deposit or as a defense to any action based upon the neglect or refusal to execute a contract.

3.9.1 Evaluation of Responsiveness
The responsiveness of bidders will be judged on the basis of the completeness of the bid submitted. To be responsive, a Bid must be submitted on the forms provided as part of the Bid Documents and comply with all the requirements of the Instruction to Bidders. Within two (2) business days of the bid opening, the bidder must provide an approved Schedule of Values.

3.9.2 Evaluation of Responsibility
To be judged as responsible, the bidder shall:

- a. Have adequate financial resources for performance, the necessary experience, organization, technical qualifications, and facilities, or a firm commitment to obtain such by subcontracts;
- b. Be able to comply with the required completion schedule for the project;
- c. Have a satisfactory record of integrity, judgment, and performance, including, in particular, any prior performance on contracts from the District;
- d. Have an adequate financial management system and audit procedures, that provide efficient and effective accountability and control of all property, funds, and assets;
- e. Conform to the civil rights, equal employment opportunity and labor law requirements of the Bid Documents.
- f. Have satisfactorily completed no less than three (3) sanitary sewer system contracts within the past five (5) years of equal or greater value to the bid being submitted.

3.10 The Rejection of Bids
The District reserves the right to reject any bid if the evidence submitted in the statement of the bidder's qualifications, or if investigation of such bidder fails to satisfy the District that such bidder is properly qualified to carry out the obligations and to complete the work contemplated therein. Any or all proposals will be rejected if there is reason to believe that collusion exists among the bidders. Conditional bids will not be accepted. The District reserves the right to reject any and all bids and to accept the bid which they deem most favorable to the interest of the District after all proposals have been examined and canvassed.

3.11 Insurance and Bonding
Contractor shall provide all necessary insurance and bonds required to complete the project. No more than ten (10) calendar days subsequent to the District’s issuance of an award letter, the Contractor shall provide documentation to prove that he has obtained all required insurance and bonds. The District shall be the sole judge as to the acceptability of any such proof.
3.11.1 General
The Contractor shall ensure that:

1. All insurance policies shall be specific to the project.

2. The insurance certificate shall state: This certifies that the insurance coverage meets or exceeds that required for Main Pump Building HVAC Upgrades, Capital Project No. 2002.

3. The District shall be named as Additional Insured in all policies; this shall include the Owners Contractors Protective Policy option.

4. All completed operations coverages and bonds shall remain in force for a period of two (2) years following acceptance of the project and completed operations shall stay in force for two (2) years following completion of the project.

3.11.2 Insurance
The Contractor shall, for the duration of the contract and for two (2) years following project acceptance, maintain the following:

1. General Liability: $1,000,000 combined single limit per occurrence for bodily injury, personal injury and property damage. If Commercial General Liability Insurance or other form with a general aggregate limit is used, either the general aggregate limit shall apply separately to this project or the general aggregate limit shall be twice the required occurrence limit. The Contractor shall provide "XCU" coverage.

2. Automobile Liability: $1,000,000 combined single limit per accident for bodily injury and property damage including coverages for owned, hired or non-owned vehicles, as applicable.

3. Workers' Compensation and Employers Liability: Workers' Compensation limits as required by statute and Employers Liability limits of $500,000 per accident and $500,000 per disease.

4. Umbrella: $2,000,000 per occurrence/aggregate for contracts valued at $500,000 or over, or $1,000,000 for contracts below $500,000. $10,000 is maximum allowable self-retained limit.

5. Errors and Omissions: If the Contractor performs professional services, he shall maintain errors and omissions insurance with a limit no lower than $1,000,000 for the duration of the contract.

The policies shall contain, or be endorsed to contain, the following provisions in the General Liability and Automobile Liability Coverage's:

a. Unless otherwise provided in paragraph “c” of this section, the District, its officers, officials, employees and volunteers shall be covered as additional insureds as respects liability arising out of activities performed by or on insured’s general supervision of the Contractor, products and completed operations of the Contractor, premises owned, occupied or used by the Contractor, or automobiles owned, leased, hired or borrowed by the Contractor. The coverage shall contain no special limitations on the scope of protection afforded to the District, its officers, officials, employees, volunteers, or agents.

b. Unless otherwise provided in paragraph “c” of this section, the Contractor’s insurance coverage shall be primary insurance as respects the District, its officers, officials, employees, volunteers, and agents. Any insurance or self-insurance maintained by the District, its officers, officials, employees, volunteers, or agents shall be excess of the Contractor’s insurance and shall not contribute with it.
c. As an acceptable alternative to provisions “a” and “b” of this section, the Contractor may provide owner's and contractor's protective liability insurance with coverage limits, named insureds, and in conformity with all applicable specifications of this section.

d. Any failure to comply with reporting provisions of the policies shall not affect coverage provided to the District, its officers, officials, employees, volunteers, or agents.

e. The Contractor’s insurance shall apply separately to each insured against whom claim is made or suit is brought, except with respect to the limits of the insurer's liability.

f. All Coverages — Each insurance policy required by this clause shall not be suspended, voided, canceled by either party, reduced in coverage, or in limits except after thirty (30) days' prior written notice by certified mail, return receipt requested, has been given to the District.

3.11.3 Best's Ratings
The District shall be the sole judge of whether or not said insurer's ratios are satisfactory. The District's decision shall be final and the District's bidding procedures contain no appeal provision.

1. Alphabetical Rating: For purposes of this Request for Bids, "insurer" shall mean any surety, insurance carrier, or other organization which proposes to provide an insurance policy or bond for the Contractor. No insurer or surety rated lower than "A-, Excellent" in the current Best's Key Rating Guide shall be acceptable to the District.

2. Financial Size Rating: Provided an insurer's alphabetical rating is satisfactory, the District will examine said insurer's financial size rating.

   a. If Best classifies the insurer XII or larger, said insurer shall be acceptable to the District.

   b. If Best classifies the insurer as smaller than XII, but larger than VI, said insurer shall be submitted to the District’s Business Manager and/or the District’s insurance consultant for review.

   Financial Size ratings less than VII are not acceptable and will disqualify the Contractor.

3.11.4 Performance Bond and Labor & Materials Payment Bond Form
The Contractor shall provide a Performance Bond and Labor & Materials Payment Bond form acceptable to the District. The performance bond shall be for either 100% of the contract price or for the Contractor’s unit price times the estimated number of units, as applicable.

This Request for Bids contains a Performance Bond and a Labor & Material Bond form for the Contractor’s use.

If the Contractor fails to provide acceptable bonds within the specified time, he shall be in default.

3.11.5 Correction of Contractor’s Insurance or Bond Deficiencies
If the District determines that the Contractor’s insurance or bond documentation does not conform to these specifications, the District shall inform said Contractor of the non-conformity. If said Contractor fails to provide conforming insurance or bond documentation within five (5) calendar days of the District's deficiency notice, he shall be in default.

3.11.6 Indemnification Clause
Contractor shall protect, indemnify, hold and save harmless and defend the District, its officers, officials, employees, volunteers, and agents against any and all claims, costs, causes, actions and expenses, including but not limited to attorney's fees incurred by reason of a lawsuit or claim for
compensation arising in favor of any person, including the employees, officers, independent contractors, or subcontractors of the Contractor or District, on account of personal injuries or death, or damages to property occurring, growing out of, incident to, or resulting directly or indirectly from the performance by the Contractor or subcontractor, whether such loss, damage, injury or liability is contributed to by the negligence of the District or by premises themselves or any equipment thereon whether latent or patent, or from other causes whatsoever, except that the successful bidder shall have no liability for damages or the costs incident thereto caused by the sole negligence of the District.

The indemnification shall not be limited by a limitation on amount or type of damages payable by or for the Contractor or its subcontractor under any employee benefits act including, but not limited, to the Workers Compensation Act.

No inspection by the District, its employees, or agents shall be deemed a waiver by the District of full compliance with the requirements of the Contract. This indemnification shall not be limited by the required minimum insurance coverages in the Contract.

3.12 Tax Exemption

The District is exempt, by law, from paying bidder Federal Excise Tax and Illinois Retailers' Occupational Tax. Therefore, the bidder shall exclude those taxes from his bid. The District's tax exemption number is E9992-3696-06. The bidder shall include all applicable taxes in his bid price.
ARTICLE 3 — DETAILED SPECIFICATIONS

Rock River Water Reclamation District

Main Pump HVAC Upgrades
Capital Project No. 2002

TABLE OF CONTENTS-TECHNICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>DIVISION 01 – GENERAL REQUIREMENTS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>010000 PROJECT REQUIREMENTS</td>
<td>10</td>
</tr>
<tr>
<td>011500 TEMPORARY FACILITIES</td>
<td>5</td>
</tr>
<tr>
<td>013300 SUBMITTAL PROCEDURES</td>
<td>4</td>
</tr>
<tr>
<td>014200 REFERENCES</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DIVISION 02 – EXISTING CONDITIONS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>024119 SELECTIVE DEMOLITION</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DIVISION 07 – THERMAL AND MOISTURE PROTECTION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>070150 PREPARATION FOR RE-ROOFING</td>
<td>3</td>
</tr>
<tr>
<td>075423 THERMOPLASTIC POLYOLEFIN ROOFING</td>
<td>8</td>
</tr>
<tr>
<td>076200 METAL FLASHINGS</td>
<td>4</td>
</tr>
<tr>
<td>077200 ROOF ACCESSORIES</td>
<td>4</td>
</tr>
<tr>
<td>078413 PENETRATION FIRESTOPPING</td>
<td>3</td>
</tr>
<tr>
<td>079200 JOINT SEALANTS</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DIVISION 8 - OPENINGS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>086200 SKYLIGHTS</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DIVISION 22 - PLUMBING</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>221413 STORM DRAINAGE PIPING AND SPECIALTIES</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>230130 HVAC REFURBISHING</td>
<td>8</td>
</tr>
<tr>
<td>230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT</td>
<td>3</td>
</tr>
<tr>
<td>230517 SLEEVES AND SLEEVE SEALS FOR HVAC PIPING</td>
<td>4</td>
</tr>
<tr>
<td>230523 BALL VALVES FOR HVAC PIPING</td>
<td>7</td>
</tr>
<tr>
<td>230529 HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT</td>
<td>7</td>
</tr>
<tr>
<td>230548 VIBRATION CONTROLS FOR HVAC</td>
<td>2</td>
</tr>
<tr>
<td>230553 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT</td>
<td>4</td>
</tr>
<tr>
<td>230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC</td>
<td>10</td>
</tr>
<tr>
<td>230719 HVAC PIPING INSULATION</td>
<td>20</td>
</tr>
<tr>
<td>230924 CONTROL VALVES</td>
<td>9</td>
</tr>
<tr>
<td>230925 FLOW INSTRUMENTS</td>
<td>12</td>
</tr>
<tr>
<td>230926 CONTROL DAMPERS</td>
<td>8</td>
</tr>
<tr>
<td>230927 GAS INSTRUMENTS</td>
<td>8</td>
</tr>
<tr>
<td>230930 PRESSURE INSTRUMENTS</td>
<td>10</td>
</tr>
</tbody>
</table>

Not to be used for bidding purposes
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>230931</td>
<td>TEMPERATURE INSTRUMENTS</td>
<td>13</td>
</tr>
<tr>
<td>230993</td>
<td>SEQUENCE OF OPERATIONS FOR HVAC</td>
<td>5</td>
</tr>
<tr>
<td>231010</td>
<td>MONITORING AND CONTROL SYSTEM (MCS) FOR HVAC</td>
<td>28</td>
</tr>
<tr>
<td>231213</td>
<td>NATURAL-GAS PIPING</td>
<td>8</td>
</tr>
<tr>
<td>232113</td>
<td>HYDRONIC PIPING</td>
<td>9</td>
</tr>
<tr>
<td>233113</td>
<td>METAL DUCTS</td>
<td>11</td>
</tr>
<tr>
<td>233116</td>
<td>NON-METAL DUCTS</td>
<td>9</td>
</tr>
<tr>
<td>233300</td>
<td>AIR DUCT ACCESSORIES</td>
<td>5</td>
</tr>
<tr>
<td>233413</td>
<td>AXIAL HVAC FANS</td>
<td>6</td>
</tr>
<tr>
<td>233423</td>
<td>HVAC POWER VENTILATORS</td>
<td>8</td>
</tr>
<tr>
<td>233713</td>
<td>REGISTERS AND GRILLES</td>
<td>2</td>
</tr>
<tr>
<td>233723</td>
<td>HVAC GRAVITY VENTILATORS</td>
<td>5</td>
</tr>
<tr>
<td>260519</td>
<td>LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES</td>
<td>6</td>
</tr>
<tr>
<td>260523</td>
<td>CONTROL-VOLTAGE ELECTRICAL POWER CABLES</td>
<td>8</td>
</tr>
<tr>
<td>260526</td>
<td>GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS</td>
<td>3</td>
</tr>
<tr>
<td>260529</td>
<td>HANGARS AND SUPPORTS FOR ELECTRICAL SYSTEMS</td>
<td>4</td>
</tr>
<tr>
<td>260533</td>
<td>RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS</td>
<td>8</td>
</tr>
<tr>
<td>260544</td>
<td>SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS</td>
<td>4</td>
</tr>
<tr>
<td>260553</td>
<td>IDENTIFICATION FOR ELECTRICAL SYSTEMS</td>
<td>7</td>
</tr>
<tr>
<td>262726</td>
<td>WIRING DEVICES</td>
<td>4</td>
</tr>
<tr>
<td>262813</td>
<td>FUSES</td>
<td>2</td>
</tr>
<tr>
<td>262816</td>
<td>ENCLOSED SWITCHES AND CIRCUIT BREAKERS</td>
<td>6</td>
</tr>
<tr>
<td>262913</td>
<td>ENCLOSED CONTROLLERS</td>
<td>6</td>
</tr>
<tr>
<td>262923</td>
<td>VARIABLE FREQUENCY MOTOR CONTROLLERS</td>
<td>10</td>
</tr>
<tr>
<td>264100</td>
<td>LIGHTNING PROTECTION SYSTEM</td>
<td>5</td>
</tr>
<tr>
<td>265119</td>
<td>LED INTERIOR LIGHTING</td>
<td>8</td>
</tr>
<tr>
<td>284621</td>
<td>ADDRESSABLE FIRE-ALARM SYSTEMS</td>
<td>11</td>
</tr>
</tbody>
</table>

**END OF TABLE OF CONTENTS**
SECTION 01 00 00 – PROJECT REQUIREMENTS

1.0 GENERAL DESCRIPTION OF WORK

The Work to be performed under these Contract Documents is generally described as follows:

This project consists of removing and replacing the existing roof, along with Skylights, the Roof Hatch, and three Rooftop Exhaust Fans REF-2, REF-3, and REF-4. Inside the building, Supply Fan S-1 will also be replaced along with the associated outdoor air dampers and actuators. Air handling Units HV-1 and HV-2 will be refurbished and the existing ductwork associated with HV-2 will be replaced with Fiberglass Reinforced Plastic (FRP) Ductwork. Associated ductwork with E-1 and E-2 will also be replaced with Fiberglass Reinforced Plastic (FRP). A new Direct Digital Control system will be installed to control all new and existing HVAC equipment, and a new Fire Alarm System will also be installed. The project will also include the replacement of lighting in the lower pump and motor rooms, along with replacement of the existing Gas Detection System.

2.0 UNITS OF MEASUREMENT

Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

3.0 WORK BY OWNER

Owner shall perform certain activities in connection with the Project with its own personnel as follows:

The Owner will operate the existing plant during construction.

4.0 OFFSITE STORAGE

Offsite storage arrangements shall be approved by Owner for all materials and equipment. Such offsite storage arrangements shall be presented in writing, and shall afford adequate and satisfactory security and environmental protection. Offsite storage facilities shall be accessible to Owner and Engineer. Applications for Payment for equipment stored off-site shall not be accepted; materials and equipment shall be paid in full and stored on site prior to requesting reimbursement.

5.0 ITEMS FURNISHED BY OWNER

5.01 Items to be re-used. Contractor shall provide Owner an opportunity to inspect items intended to be removed and re-used as part of the Work. Owner shall have the right to provide substitute materials if salvage items are not desired for re-use as indicated in the Contract Documents.

6.0 SUBSTITUTES AND "OR-EQUAL" ITEMS

Provisions for evaluation of substitutes and "or-equal" items of materials and equipment are covered in Paragraph 6.05 of the General Conditions. Requests for review of equivalency will not be accepted by Engineer from anyone except Contractor, and such requests will not be considered until after the Effective Date of the Agreement.

7.0 PREPARATION FOR SHIPMENT

All materials shall be suitably packaged to facilitate handling, and protected against damage during transit and storage. Painted surfaces shall be protected against impact, abrasion, discoloration, and other
damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

Each item, package, or bundle of material shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.

8.0 LAND FOR CONSTRUCTION PURPOSES

Contractor will be permitted to use available land belonging to Owner, on or near the Site, for construction purposes and for storage of materials and equipment. Site trailer and materials staging area can be on the eastern half of the paved area northwest of the Main Pump Station, toward Aeration Splitter Box.

Contractor shall immediately move stored materials or equipment if any occasion arises, as determined by Owner, requiring access to the storage area. Materials or equipment shall not be placed on the property of Owner until Owner has agreed to the precise location to be used for storage.

9.0 EQUIPMENT

The Contractor shall not be permitted to use existing, District-owned equipment.

The Contractor shall provide all materials and equipment in suitable and adequate quantities as required to accomplish the work shown, specified herein, and as required to complete the project. Devices, ladders, and other tools or equipment belonging to the District shall not be used to accomplish this work.

If District's tools or equipment obstruct the work, Contractor shall notify the District's Representative and request that the District temporarily relocate such items until such time as work has been accomplished. If District’s tools or equipment are missing or damaged during the duration of the work, Contractor shall be responsible for replacement or repair to a condition that existed prior to the commencement of the work.

All tools, materials and equipment shall be clearly labeled with names of Contract and Contractor. Containers of materials and equipment shall also include labeling indicating contents.

10.0 OPERATION OF EXISTING FACILITIES

The existing facilities must be kept in continuous operation throughout the construction period. No interruption will be permitted which adversely affects the degree of service currently provided. Contractor shall provide Temporary Facilities per Section 01 15 00 and make temporary modifications as necessary to keep the existing facilities in operation during the construction period. Due to potential health hazards and requirements of State of Illinois Environmental Protection Agency and U.S. EPA, existing wastewater treatment facilities must be maintained in operation during construction. Degree of treatment during construction shall be equal to or exceed efficiency of facility before construction started.

Operations shall be done in such manner as to avoid hazards to persons and property and interference with the use of adjacent areas or interruption of free passage to and from such areas. Care shall also be taken to prevent the spread of dust and flying particles.

Owner access to the Main Pump Building must be maintained at all times.

Guidelines for key portions of the facility are provided herein. The allowable length of time for all other planned outages shall be closely coordinated with RRWRD Operations and shall not exceed 60 minutes without prior written permission from Owner.
10.01. Active Connections. As shown on the Drawings, several existing and active connections will be traversed as part of the Work. When required and with Owner permission, these may be taken out of service for short periods of time. The allowable length of time for each service outage shall be coordinated with the Owner, but shall not exceed 4 hours.

Unless otherwise noted, the Contractor shall assume that all process piping and electrical wiring is in service.

Where interference with facilities occurs, cooperate with District to eliminate interference. Operation of breakers or other disconnecting means on the existing electrical equipment, when required, shall be by or under the direct supervision of the Owner.

Take whatever precautions are necessary to prevent any damage to existing buildings and structures which are to remain, and promptly repair any such damage that occurs as a result of construction.

Cease operations and notify the District’s Representative immediately if adjacent appurtenances appear to be endangered in any way. Do not resume operations until corrective measures have been taken.

11.0 CONNECTIONS TO EXISTING FACILITIES

Unless otherwise specified or indicated, Contractor shall make all necessary connections to existing facilities, including structures, drain lines, and utilities such as water, sewer, gas, telephone, and electric. In each case, Contractor shall receive permission from Owner or the owning utility prior to undertaking connections. Contractor shall protect facilities against deleterious substances and damage.

Connections to existing facilities which are in service shall be thoroughly planned in advance, and all required equipment, materials, and labor shall be on hand at the time of undertaking the connections. Work shall proceed continuously (around the clock) if necessary to complete connections in the minimum time. Operation of electrical devices, valves or other appurtenances on existing utilities, when required, shall be by or under the direct supervision of the owning utility.

12.0 UNFAVORABLE CONSTRUCTION CONDITIONS

During unfavorable weather, wet ground, or other unsuitable construction conditions, Contractor shall confine its operations to work which will not be affected adversely by such conditions. No portion of the Work shall be constructed under conditions which would affect adversely the quality or efficiency thereof, unless special means or precautions are taken by Contractor to perform the Work in a proper and satisfactory manner.

13.0 CUTTING AND PATCHING

As provided in General Conditions, Contractor shall perform all cutting and patching required for the Work and as may be necessary in connection with exposing Work for inspection, or for the correction of defective Work.

Contractor shall perform all cutting and patching required for and in connection with the Work, including but not limited to the following:

- Removal of improperly timed Work.
- Removal of samples of installed materials for testing.
Alteration of existing facilities.

Installation of new Work in existing facilities.

Contractor shall provide all shoring, bracing, supports, and protective devices necessary to safeguard all Work and existing facilities during cutting and patching operations. Contractor shall not undertake any cutting or demolition which may affect the structural stability of the Work or existing facilities without Engineer's concurrence.

Materials shall be cut and removed to the extent indicated on the Drawings or as required to complete the Work. Materials shall be removed in a careful manner, with no damage to adjacent facilities or materials. Materials which are not salvageable shall be removed from the site by Contractor.

All Work and existing facilities affected by cutting operations shall be restored with new materials, or with salvaged materials acceptable to Engineer, to obtain a finished installation with the strength, appearance, and functional capacity required. If necessary, entire surfaces shall be patched and refinished.

Where new Work is to be installed or suspended concealing existing surfaces or spaces, Contractor shall remove foreign substances such as grease, sludge, and odoriferous materials before starting Work.

Where surfaces are to remain exposed, Contractor shall remove foreign substances such as grease, sludge, and odoriferous material.

14.0 HAZARDOUS ENVIRONMENTAL CONDITIONS AT SITE

No Hazardous Environmental Conditions at the Site in areas that will be affected by the Work are known to the Owner.

14.01 Previously Unidentified Hazardous Environmental Conditions. If, during the progress of the Work, previously unidentified Hazardous Environmental Conditions are identified, Contractor shall stop work in the affected area and immediately notify the Owner and Engineer in accordance with the requirements in the General Conditions. At the Owner's discretion, the Owner may instruct the Contractor to engage an abatement Subcontractor qualified to perform abatement of the suspected Hazardous Environmental Condition identified, to verify the materials and, if necessary, encapsulate, enclose, or remove and dispose of all ACM, Metal Bearing Protective Coatings, Paints, and Linings, Contaminated Environmental Media, and/or other Hazardous Substances in accordance with current regulations of the Environmental Protection Agency and the U. S. Department of Labor - Occupational Safety and Health Administration, the applicable state regulating agency, and any local government agency. Payment for such work will be made by Change Order.

15.0 CLEANING UP

Contractor shall keep the premises free at all times from accumulations of waste materials and rubbish, as well as spillage from connections to existing piping. Contractor shall provide adequate trash receptacles about the Site and shall promptly empty the containers when filled.

Perform daily cleaning and final cleaning to District’s satisfaction.

1. Clean District-occupied areas daily. Debris shall not be allowed to accumulate. Excess debris and waste material shall be removed from the site daily as the work progresses.
2. Clean spillage, overspray, and heavy collection of dust in District-occupied areas immediately. At completion of alteration and work in area, provide final cleaning and return space to condition suitable for use by District.
Where existing materials, equipment and debris are to be removed, Contractor shall be responsible for removal and disposal. Disposal shall be in accordance with all applicable codes and regulations. Remove materials from the site as work progresses. Leave areas in clean condition upon completion of the work. Remove all temporary work.

Construction materials, such as concrete forms and scaffolding, shall be neatly stacked by Contractor when not in use. Contractor shall promptly remove splattered concrete, asphalt, oil, paint, corrosive liquids, and cleaning solutions from surfaces to prevent marring or other damage.

Volatile wastes shall be properly stored in covered metal containers and removed daily.

Wastes shall not be buried or burned on the Site or disposed of into storm drains, sanitary sewers, streams, or waterways. All wastes shall be removed from the Site and disposed of in a manner complying with local ordinances and antipollution laws.

Adequate cleanup will be a condition for recommendation of progress payment applications.

16.0 APPLICABLE CODES

References in the Contract Documents to local codes mean the following:

- ICC International Building Code (with local amendments), 2015 edition
- ICC International Existing Building Code (with local amendments), 2015 edition
- ICC International Fire Code (with local amendments), 2015 edition
- ICC International Mechanical Code (with local amendments), 2015 edition
- ICC International Fuel Gas Code (with local amendments), 2015 edition
- IDPH Illinois Plumbing Code (with local amendments), 2014 edition
- NFPA 70 National Electric Code (with local amendments), 2014 edition
- ASTM Material Standards
- Other standard codes which apply to the Work are designated in the Specifications.

17.0 PRECONSTRUCTION CONFERENCE

Prior to the commencement of Work at the Site, a preconstruction conference will be held at a mutually agreed time and place. The conference shall be attended by:

Contractor and its superintendent.

Principal Subcontractors.

Representatives of principal Suppliers and manufacturers as appropriate.

Engineer and its Resident Project Representative.

Representatives of Owner.
Government representatives as appropriate.

Others as requested by Contractor, Owner, or Engineer.

Unless previously submitted to Engineer, Contractor shall bring to the conference a preliminary schedule for each of the following:

- Progress Schedule.
- Procurement Schedule.
- Schedule of Values for progress payment purposes.
- Schedule of Shop Drawings and other submittals.

The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The agenda will include:

- Contractor's preliminary schedules.
- Transmittal, review, and distribution of Contractor's submittals.
- Processing Applications for Payment.
- Maintaining record documents.
- Critical Work sequencing.
- Field decisions and Change Orders.
- Use of premises, office and storage areas, security, housekeeping, and Owner's needs.
- Major equipment deliveries and priorities.
- Contractor's assignments for safety and first aid.

The owner will preside at the conference and the prime contractor will arrange for keeping the minutes and distributing the minutes to all persons in attendance.

18.0 PROGRESS MEETINGS

Contractor shall schedule and hold regular progress meetings at least every other week and at other times as requested by Owner, Engineer or as required by progress of the Work. Contractor, Engineer, and all Subcontractors active on the Site shall be represented at each meeting. Contractor may at its discretion request attendance by representatives of its Suppliers, manufacturers, and other Subcontractors.

Contractor shall preside at the meetings. Meeting minutes shall be prepared and distributed by Contractor. The purpose of the meetings will be to review the progress of the Work, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop.
19.0 SITE ADMINISTRATION

Contractor shall be responsible for all areas of the Site used by it and by all Subcontractors in the performance of the Work. Contractor shall exert full control over the actions of all employees and other persons with respect to the use and preservation of property and existing facilities, except such controls as may be specifically reserved to Owner or others. Contractor shall have the right to exclude from the Site all persons who have no purpose related to the Work or its inspection, and may require all persons on the Site (except Owner’s employees) to observe the same regulations as Contractor requires of its employees.

Confine all work operations and activities to the immediate and general vicinities as may be necessary to complete the specified work.

Contractor shall coordinate construction operations with the District.

Assume full responsibility for protection and safekeeping of material and products stored on or off premises.

Move any stored material or products which interfere with operations of District or other Contractors.

The Contractor shall be allowed reasonable use of available on-site 120-V electrical power sources for hand held tools, ancillary lighting, etc., as long as it does not interfere with the normal functioning of District operations and as long as the usage does not develop into an abuse. Any power needs greater than 120-V shall be the Contractor’s responsibility.

20.0 SCHEDULE AND SEQUENCE OF OPERATIONS

20.01 Progress of the Work The work shall be performed at such times and in or on such parts of the project and with such forces, materials and equipment to prevent any delay to the completion of the project within the time limits stated in the, and in accordance with the sequences and constraints specified herein.

20.2 Work Hours

The Contractor may, with written approval from the District and acquisition of all necessary permits, and at the Contractor’s own expense carry on work outside regular hours of 6:30 a.m. to 4:00 p.m., Monday through Friday excluding holidays for work inside the District’s (District’s) Plant grounds. To obtain District consideration of work outside the above-mentioned hours, or on Saturdays, Sundays or holidays, the contractor shall submit a written request, with reasons, to the Engineer and shall allow 48 hours for written approval and satisfactory arrangements to be made for observing the work in progress. The Contractor shall comply with all applicable requirements of the District. For work within District Wastewater Treatment Plant grounds, all issues relating to timing and access must be cleared with the District and the District’s inspector and coordinated with the Guard in shack at Plant Grounds entrance.

Such permission, however, shall be subject to revocation if the Contractor fails to maintain adequate equipment and supervision for the proper execution and control of the work.

20.03 Sequences and Constraints

The Contractor shall plan, schedule and coordinate his work to minimize the amount of time existing facilities are out of service due to construction. All scheduled outages shall be no greater than 60 minutes. During the entire period of the contract, provide restoration of any unscheduled power interruption within 30 minutes during regular business hours, and within 2 hours at night and on weekends. Coordination with
District operating staff shall be done through the Engineer and the District’s On-site Representative. The Contractor shall be responsible for scheduling his work per the sequences and constraints specified herein.

The Contractor shall perform all work in a manner so as not to interfere with other utility lines (water, sanitary, gas etc.) in the vicinity. All construction activities shall be coordinated and scheduled with the District so as to minimize conflicts with ongoing operations and other construction work. Required removals and relocations of existing piping, wiring and related appurtenances shall be coordinated with the District.

Contractor shall be responsible for all temporary electrical, piping and any other facilities required to minimize the amount of time the various operations are out of service. Downtime of certain operations and/or processes may be allowed with District’s approval.

Before any shutdown coordination takes place, verify that all equipment, materials, and other necessary items required for shutdown work are on-site and prepared for installation. Pre-fabricate as much of this work as possible for accurate and proper installation.

Any modifications to existing equipment, piping, electrical, etc. required to remove and/or install new equipment shall be approved by the Engineer and performed at the sole expense of the Contractor.

The following sequences and constraints are essential to reducing downtime of facilities due to construction and the time of completion of this project.

Unless otherwise specified, the Contractor shall provide RRWRD Staff with 48 hours advanced notice to request a shutdown or outage of any existing facility needed to complete the work. The Contractor shall provide evidence that all necessary equipment items are on hand or on site at the time of the request. All system shutdowns or outages must be approved by the Rock River Water Reclamation District. District reserves right to place facilities taken out of service back into service on emergency basis upon notification to Contractor. It shall be the Contractor’s responsibility to clean the facilities to enable construction and to transport any waste materials removed to an appropriate on-site location (Plant grounds) directed by the Engineer. The Contractor shall be fully responsible for providing all temporary piping, electrical work, heating, ventilating, air conditioning, lighting, temporary structures, and related work to minimize the time operations are out of service. Not all details of construction are necessarily shown on the Drawings or covered in the Specifications. However, this does not relieve the Contractor of the responsibility of avoiding interruptions to processes that are essential to the safe and normal functioning of various plant operations. All utilities shall be located and marked prior to construction.

20.04 Overall Construction Schedule

The Overall Schedule shall begin with the date the District issues the Notice to Proceed and conclude with the date of Final Completion of the Contract. Failure to submit a project schedule will be considered cause for withholding of any partial payments otherwise due under the Contract in accordance with the General Conditions.

Contractor shall provide a detailed written construction sequencing plan prior to the start of work. The sequencing plan included with the project drawings provides a minimum scope for bidding purposes. The detailed plan shall include a schedule of all work with special attention given to the transitions to/from temporary facilities.

20.05 Delays and Recovery

If it becomes evident the work will not be completed by the contract completion date, the Contractor shall submit a revised schedule outlining the additional amount of time needed to expedite completion of the remaining work. Contractor shall be liable for liquidated damages for all unjustifiable delays per the terms of the contract.
Once the Contractor starts on any part of the work which could potentially impact the safe and normal operation of various District (Plant) facilities, he shall diligently and expeditiously prosecute such work until such time that the potential for deleterious impact is avoided.

Whenever it becomes apparent from the current progress of construction that the interface completion dates and/or contract completion dates will not be met, the Contractor shall take some or all of the following actions:

1. Increase construction manpower in such quantities and crafts as shall substantially eliminate the backlog of work.
2. Increase the number of working hours per shift, shifts per work day, work days per week, or the amount of construction equipment, or any combination of the foregoing sufficient to substantially eliminate the backlog of work.
3. Reschedule work items to achieve concurrency of accomplishment.

The addition of equipment or construction forces, increasing the working hours or any other method, manner or procedure needed to make up for time lost due to avoidable delays shall not be considered justification for a Change Order or regarded as an acceleration order.

21.0 SITE PREPARATION

21.01 Preconstruction Videotaping. The District may conduct videotaping of the site and all existing appurtenances prior to construction. Videotaping is intended for use as evidence in ascertaining the extent of any damage which may occur as a result of the Contractor’s operations and is for the protection of the Contractor and the District. Videotaping will provide a means of determining whether and to what extent damage may have occurred as a result of the Contractor’s operations.

21.02 Responsibility. The Contractor shall be responsible for determination of the full extent and nature of the work involved in disconnection and removing existing materials and equipment by careful review of the Plans and Specifications and by conducting a thorough inspection of the project site and surrounding areas prior to submitting a bid. The Contractor shall contact the District’s Representative to arrange a site visit during normal working hours. Failure to do this shall not relieve the Contractor of responsibility to complete this work for the bid price submitted. Conduct site preparation work to minimize interference with other work being performed in vicinity.

21.03 Existing Conditions

Some existing conditions may not be shown. Bidders are advised to carefully inspect the existing sites before preparing their proposals. The removal of minor obstructions encountered that are not shown on the drawings, but could have been foreseen by visual inspection of the site prior to bidding, shall be anticipated and accomplished without a cost adjustment to the contract, even though not shown or specifically mentioned.

Major obstructions encountered that are not shown on the drawings, or could not have been foreseen by visual inspection of the site prior to bidding, should immediately be brought to the attention of the District’s Representative. The District’s Representative will make a determination before proceeding with the Work. If the District’s Representative finds that the obstruction adversely affects the Contractor’s cost or schedule for completion, an appropriate adjustment to the contract will be made.

The approximate location of the existing items to be moved or removed is shown on the drawings. All site preparation work shall be coordinated between the specifications and all drawings. Site preparation requirements identified on the drawings shall not be limited to those explicitly identified on drawings.
21.04 Repair Of Damage. Material for repair of facilities damaged and disturbed during site preparation work shall be equal to that existing prior to the start of the work.

21.05 Site Work

Perform work so as not to interfere with the work of other contracts in vicinity.

Work equipment shall be selected and operated such that structures, utilities, and other existing works that are to remain will not be damaged and cause injury to workers.

Provide temporary shoring, bracing, and other means to ensure safety of workers during demolition and removal.

22.0 PROTECTION OF PROPERTY

Provide, erect and maintain temporary barriers and barricades, as required, around the demolition work area to prevent the personnel from entering the work vicinity.

The Contractor shall protect the existing buildings, structures and property, in the vicinity of the work from damage. The Contractor shall provide bracing and shoring as necessary. The Contractor shall also protect other miscellaneous items, such as manholes and piping, which are not a part of the proposed work.

The Contractor shall protect existing property, roads, walks, equipment, or vehicles, and other potentially impacted items, which are not a part of the proposed work, which may be in the vicinity of the proposed work.

Perform work with trades qualified to perform work in manner causing least damage to each type of work.

Dust, dirt, and debris shall be controlled to protect existing equipment and operations from shutdown.

Contractor shall provide watertight and dust-tight enclosures for existing equipment that may be affected by operation of concrete saws, drills, or other work activities. Contractor shall ensure that protective enclosures do not shut down equipment due to excessive heat accumulation.

Give special attention to fire protection in areas where welding will be performed. Flame cutting shall not be permitted without special approval by the District’s Representative. Protect combustible materials. Provide dry chemical extinguisher and train workers in their use.

Maintain in service and protect from damage and leakage, all existing utilities that are not being removed or replaced.

END OF SECTION 01 00 00
SECTION 01 15 00 – TEMPORARY FACILITIES

1. OFFICE AT SITE OF WORK

A. During the performance of this Contract, Contractor shall maintain a suitable office area at the Site which shall be the headquarters of its representative authorized to receive drawings, instructions, or other communication or articles. Any communication given to the said representative or delivered at Contractor’s office at the Site in the representative’s absence shall be deemed to have been delivered to Contractor.

B. Copies of the Drawings, Specifications, and other Contract Documents shall be kept at Contractor’s office at the Site and available for use at all times.

2. WATER

A. Except as listed herein, all water required for and in connection with the Work to be performed will be furnished by Owner in the vicinity of the Site without charge to Contractor, provided:

1. Contractor shall procure such water in the location and in the manner designated by Engineer.
2. Contractor at its own expense shall make authorized connections and provide means for delivering the water to the Site.
3. Contractor shall provide adequately against waste and needless use of water.

B. Potable water used for domestic purposes, including drinking and handwashing, shall be supplied by the Contractor.

3. POWER

A. Contractor shall be responsible for all electrical power usage in the work area and staging area along with all of their subcontractors. Contractor may purchase power from the Owner if the Contractor does not want to provide his own power. To purchase power, Contractor shall coordinate with the Owner where to connect to the Owner’s Power, provide a meter, and make payments to the Owner. The Owner will charge the Contractor only the Owner’s cost for power.

B. Miscellaneous power will be made available to the Contractor by Owner at no cost to the Contractor, subject to the following conditions:

1. Existing lighting systems may be utilized by Contractor to the extent available. Any necessary additional or temporary lighting systems shall be provided by Contractor at no additional cost to Owner.
2. Power will be available at 120 volts, 60 Hz, single phase at convenience receptacles. No 480 volt power will be available.
3. Electrical power shall be used only in such quantities as will not interfere with Owner’s requirements, and care shall be taken not to overload the existing facilities. Contractor shall provide any additional or temporary electrical power or power of other voltages it may require for prosecution of the Work.
C. These provisions shall not be construed as a guarantee by Owner of the uninterrupted continuation of power, and interruptions beyond the control of Owner shall not be reason for claims for additional costs nor for extensions of time. Contractor shall provide, at no additional cost to Owner, any necessary power required for prosecution of the Work during such interruptions.

4. VOICE AND DATA SERVICES

A. Contractor shall make all necessary arrangements and pay all installation charges for voice and data lines in its offices at the Site.

5. SANITARY FACILITIES

A. Contractor shall furnish temporary sanitary facilities at the Site, as provided herein, for the needs of all construction workers and others performing work or furnishing services on the Project.

B. Sanitary facilities shall be of reasonable capacity, properly maintained throughout the construction period, and obscured from public view to the greatest practical extent. Contractor shall furnish at least one toilet facility for each 20 workers at the site. Contractor shall provide at least one handwashing station next to each temporary sanitary facility. Contractor shall enforce the use of such sanitary facilities by all personnel at the Site.

6. MAINTENANCE OF TRAFFIC

A. Contractor shall conduct its work to interfere as little as possible with public travel or facility traffic, whether vehicular or pedestrian. Whenever it is necessary to cross, obstruct, or close roads, driveways, and walks, whether public or private, Contractor shall provide and maintain suitable and safe bridges, detours, or other temporary expedients for the accommodation of public and private travel, and shall give reasonable notice to owners of private drives before interfering with them. Such maintenance of traffic will not be required when Contractor has obtained permission from the owner and tenant of private property, or from the authority having jurisdiction over public property involved, to obstruct traffic at the designated point.

B. In making open-cut street crossings, Contractor shall not block more than one-half of the street at a time. Whenever possible, Contractor shall widen the shoulder on the opposite side to facilitate traffic flow. Temporary surfacing shall be provided as necessary on shoulders.

7. BARRICADES AND LIGHTS

A. All streets, roads, highways, and other public thoroughfares which are closed to traffic shall be protected by effective barricades on which shall be placed acceptable warning signs. Barricades shall be located at the nearest intersecting public highway or street on each side of the blocked section.

B. All open trenches and other excavations shall have suitable barricades, signs, and lights to provide adequate protection to the public. Obstructions, such as material piles and equipment, shall be provided with similar warning signs and lights.

C. All barricades and obstructions shall be illuminated with warning lights from sunset to sunrise. Material storage and conduct of the Work on or alongside public streets and highways shall cause the minimum obstruction and inconvenience to the traveling public.

D. All barricades, signs, lights, and other protective devices shall be installed and maintained in conformity with applicable statutory requirements and, where within railroad and highway rights-of-way, as required by the authority having jurisdiction thereover.
8. FENCES

A. All existing fences affected by the Work shall be maintained by Contractor until completion of the Work. Fences which interfere with construction operations shall not be relocated or dismantled until written permission is obtained from the owner of the fence, and the period the fence may be left relocated or dismantled has been agreed upon. Where fences must be maintained across the construction easement, adequate gates shall be installed. Gates shall be kept closed and locked at all times when not in use.

B. On completion of the Work across any tract of land, Contractor shall restore all fences to their original or to a better condition and to their original locations.

9. DAMAGE TO EXISTING PROPERTY

A. Contractor will be held responsible for any damage to existing structures, Work, materials, or equipment because of his operations and shall repair or replace any damaged structures, Work, materials, or equipment to the satisfaction of, and at no additional cost to, Owner.

B. Contractor shall protect all existing structures and property from damage and shall provide bracing, shoring, or other work necessary for such protection.

C. Contractor shall be responsible for all damage to streets, roads, curbs, sidewalks, highways, shoulders, ditches, embankments, culverts, bridges, or other public or private property, which may be caused by transporting equipment, materials, or workers to or from the Work. Contractor shall make satisfactory and acceptable arrangements with the agency having jurisdiction over the damaged property concerning its repair or replacement.

10. TREE AND PLANT PROTECTION

A. All trees and other vegetation which must be removed to perform the Work shall be removed and disposed of by Contractor; however, no trees or cultured plants shall be unnecessarily removed unless their removal is indicated on the Drawings. All trees and plants not removed shall be protected against injury from construction operations.

B. Trees considered by Engineer to have any significant effect on construction operations are indicated on the Drawings and those which are to be preserved are so indicated.

C. Contractor shall take extra measures to protect trees designated to be preserved, such as erecting barricades, trimming to prevent damage from construction equipment, and installing pipe and other Work by means of hand excavation or tunneling methods. Such trees shall not be endangered by stockpiling excavated material or storing equipment against their trunks.

D. When injuring or removal of trees designated to be preserved cannot be avoided, or when removal and replacement is indicated on the Drawings, each tree injured beyond repair or removed shall be replaced with a similar tree of the nearest size possible.

E. All trimming, repair, and replacement of trees and plants shall be performed by qualified nurserymen or horticulturists.
11. SECURITY
   A. Contractor shall be responsible for protection of the Site, and all Work, materials, equipment, and existing facilities thereon, against vandals and other unauthorized persons.
   B. No Claim shall be made against Owner by reason of any act of an employee or trespasser, and Contractor shall make good all damage to Owner's property resulting from Contractor's failure to provide security measures as specified.
   C. Security measures shall be at least equal to those usually provided by Owner to protect Owner's existing facilities during normal operation, but shall also include such additional security fencing, barricades, lighting, and other measures as required to protect the Site.

12. ACCESS ROADS
   A. Contractor may use existing access roads and pathways to various parts of the Site as required to complete the Project. Such roads shall be available at all times for the use by the district, and all others performing work or services at the site.

13. PARKING
   A. Contractor shall provide and maintain suitable parking areas for the use of all workers and others performing work or furnishing services in connection with the Project, as required to avoid any need for parking personal vehicles where they may interfere with public traffic, Owner's operations, or construction activities.

14. NOISE CONTROL
   A. Contractor shall take reasonable measures to avoid unnecessary noise. Such measures shall be appropriate for the normal ambient sound levels in the area during working hours. All construction machinery and vehicles shall be equipped with practical sound-muffling devices, and operated in a manner to cause the least noise consistent with efficient performance of the Work.
   B. During construction activities on or adjacent to occupied buildings, and when appropriate, Contractor shall erect screens or barriers effective in reducing noise in the building and shall conduct its operations to avoid unnecessary noise which might interfere with the activities of building occupants.

15. DUST CONTROL
   A. Contractor shall take reasonable measures to prevent unnecessary dust. Earth surfaces subject to dusting shall be kept moist with water or by application of a chemical dust suppressant. When practicable, dusty materials in piles or in transit shall be covered to prevent blowing dust.
   B. Buildings or operating facilities which may be affected adversely by dust shall be adequately protected from dust. Existing or new machinery, motors, instrument panels, or similar equipment shall be protected by suitable dust screens. Proper ventilation shall be included with dust screens.

16. TEMPORARY DRAINAGE PROVISIONS
   A. Contractor shall provide for the drainage of storm water and such water as may be applied or discharged on the Site in performance of the Work. Drainage facilities shall be adequate to prevent damage to the Work, the Site, and adjacent property.
   B. Existing drainage channels and conduits shall be cleaned, enlarged, or supplemented as necessary to carry all increased runoff attributable to Contractor's operations. Dikes shall be constructed as necessary to divert increased runoff from entering adjacent property (except in...
natural channels), to protect Owner’s facilities and the Work, and to direct water to drainage channels or conduits. Ponding shall be provided as necessary to prevent downstream flooding.

17. EROSION CONTROL

A. Contractor shall prevent erosion of soil on the Site and adjacent property resulting from its construction activities. Effective measures shall be initiated prior to the commencement of clearing, grading, excavation, or other operation that will disturb the natural protection.

B. Work shall be scheduled to expose areas subject to erosion for the shortest possible time, and natural vegetation shall be preserved to the greatest extent practicable. Temporary storage and construction buildings shall be located, and construction traffic routed, to minimize erosion. Temporary fast-growing vegetation or other suitable ground cover shall be provided as necessary to control runoff.

18. POLLUTION CONTROL

A. Contractor shall prevent the pollution of drains and watercourses by sanitary wastes, sediment, debris, and other substances resulting from construction activities. No sanitary wastes shall be permitted to enter any drain or watercourse other than sanitary sewers. No sediment, debris, or other substance shall be permitted to enter sanitary sewers, and reasonable measures shall be taken to prevent such materials from entering any drain or watercourse.

19. CONCRETE WASHOUT

A. Contractor shall construct and maintain an above ground, temporary concrete washout facility at a location determined by the District. The facility shall comply with the Illinois Urban Manual, Practice Standard, Code 954. The washout facility and concrete waste shall be removed upon completion of the project. The solidified concrete wash shall be considered Clean Construction or Demolition Debris (C.C.D.D.) as per the Illinois Environmental Protection Act (415 ILCS 5) and disposed of in accordance with the Act. This work shall be incidental to all other concrete work.

END OF SECTION 01 15 00
Not to be used for bidding purposes
SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 DEFINITIONS

A. Submittal Descriptions

1. Submittals requirements are specified in the technical sections. Submittals are identified by Submittal Description numbers and titles as follows:

   a. Preconstruction Submittals: Submittals which are required prior to construction which include: Certificates of insurance, Surety bonds, List of proposed Subcontractors, List of proposed products, Construction Progress Schedule, Submittal register, Schedule of prices, Health and safety plan, Work plan, Quality Control (QC) plan, and Environmental protection plan

2. Approving Authority

   a. Owner authorized to approve submittal.

3. Work

   a. As used in this section, on- and off-site construction required by contract documents, including labor necessary to produce submittals, construction, materials, products, equipment, and systems incorporated or to be incorporated in such construction.

1.2 VARIATIONS

A. Variations from contract requirements require Owner approval, and will be considered where advantageous to Owner.

1. Considering Variations

   a. Discussion with Owner prior to submission will help ensure functional and quality requirements are met and minimize rejections and re-submittals. When contemplating a variation which results in lower cost, consider submission of the variation as a Value Engineering Change Proposal (VECP).

   b. Specifically point out variations from contract requirements in transmittal letters. Failure to point out deviations may result in the rejection and removal of such work at no additional cost to the Owner.

2. Proposing Variations

   a. When proposing variation, deliver written request to the Owner, with documentation of the nature and features of the variation and why the variation is desirable and beneficial to Owner, including written analysis of the proposed variation. If lower cost is a benefit, also include an estimate of the cost savings. In addition to documentation required for variation, include the submittals required for the item. Clearly mark the proposed variation in all documentation.

3. Warranting That Variations Are Compatible

   a. When delivering a variation for approval, Contractor warrants that this contract has been reviewed to establish that the variation, if incorporated, will be compatible with other elements of work.

4. Review Schedule Is Modified
B. In addition to normal submittal review period, a period of 10 working days will be allowed for consideration by the Owner of submittals with variations.

1.3 SUBMITTAL REGISTER

A. Prepare and maintain submittal register, upon contract award. This list may not be all inclusive and additional submittals may be required.

1. Column (a) Activity Number: Activity number from the project schedule.
2. Column (b) Transmittal Number: Contractor assigned list of consecutive numbers.
3. Column (c): Lists specification section in which submittal is required.
4. Column (d): Lists each submittal description required in each specification section.
5. Column (e): Lists one principal paragraph in specification section where a material or product is specified. This listing is only to facilitate locating submitted requirements. Do not consider entries in column (e) as limiting project requirements.
6. Column (f) Contractor Submit Date: Scheduled date for approving authority to receive submittals.
7. Column (g) Contractor Approval Date: Date Contractor needs approval of submittal.
8. Column (h) Contractor Material: Date that Contractor needs material delivered to Contractor control.
9. Column (i) Action Code: Date of action used to record Contractor's review when forwarding submittals to QC.
10. Column (j) List date of submittal transmission.
11. Column (k) through (m) List Dates related to review actions.
12. Column (o) List date approval received.

B. Use of Submittal Register

1. Submit submittal register. Submit with QC plan and project schedule. Verify that all submittals required for project are listed and add missing submittals. Coordinate and complete the register submitted with the QC plan and the project schedule:

C. Copies Delivered to the Owner

1. Deliver one copy of submittal register updated by Contractor to Owner with each invoice request.

1.4 SCHEDULING

A. Schedule and submit concurrently submittals covering component items forming a system or items that are interrelated. Include certifications to be submitted with the pertinent drawings at the same time. No delay damages or time extensions will be allowed for time lost in late submittals.

1. Coordinate scheduling, sequencing, preparing and processing of submittals with performance of work so that work will not be delayed by submittal processing. Allow for potential resubmittal of requirements.

2. Submittals called for by the contract documents will be listed on the register. If a submittal is called for but does not pertain to the contract work, the Contractor is to include the submittal in the register and annotate it "N/A" with a brief explanation. Approval by the Owner does not
relieve the Contractor of supplying submittals required by the contract documents but which have been omitted from the register or marked "N/A."

3. Re-submit register and annotate monthly by the Contractor with actual submission and approval dates. When all items on the register have been fully approved, no further re-submittal is required.

4. Carefully control procurement operations to ensure that each individual submittal is made on or before the Contractor scheduled submittal date shown on the approved "Submittal Register."

1.5 OWNER APPROVING AUTHORITY

A. When approving authority is Owner, the Owner will:

1. Note date on which submittal was received.

2. Review submittals for approval only for conformance with project design concepts and compliance with contract documents. Owner shall be allocated 10 business days from the time of receipt for submittal review. Contractor to submit to owner two paper copies and an electronic copy of all final approved submittals, prior to substantial completion of the work.

3. Identify returned submittals with one of the actions defined in paragraph entitled, "Review Notations," of this section and with markings appropriate for action indicated.

B. Upon completion of review of submittals requiring Owner approval, stamp and date approved submittals. All submittals shall be in electronic format.

1.6 DISAPPROVED OR REJECTED SUBMITTALS

A. Contractor shall make corrections required by the Owner. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or specifications; notice as required under the clause entitled, "Changes," is to be given to the Owner. Contractor is responsible for the dimensions and design of connection details and construction of work. Failure to point out deviations may result in the Owner requiring rejection and removal of such work at the Contractor's expense.

B. If changes are necessary to submittals, the Contractor shall make such revisions and submission of the submittals in accordance with the procedures above. No item of work requiring a submittal change is to be accomplished until the changed submittals are approved.

1.7 APPROVE SUBMITTALS

A. Approval or acceptance will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor under the Contractor Quality Control (CQC) requirements of this contract is responsible for.

B. After submittals have been approved or accepted by the Owner, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary. Contractor shall provide Owner with 2 paper copies of all approved shop drawing submittals, prior to Contractor's request for final payment.

1.8 OPERATION & MAINTENANCE (O&M) MANUALS AND AS-BUILT DRAWINGS

A. O & M Manuals
1. At termination of work, the Contractor and each major Subcontractor, as it applies to his work, shall submit 3 paper copies and an electronic copy of an operation and maintenance manual presenting full details of care, maintenance and operation of mechanical equipment and other operable equipment of every nature. Manuals shall include such things as:
   a. Manufacturer’s instructions for care
   b. Spare parts lists and sources of supply
   c. Wiring diagrams
   d. Control diagrams, etc
   e. Testing results

2. The O&M manuals shall be compiled into hard covered 3–ring binders and submitted by the Contractor to the Owner for review and approval.

B. As-Built Drawings

1. Submit detail drawings showing final equipment layout, including assembly and installation details and electrical connection diagrams; piping layout showing the location of all supports and hangers, typical hanger details, reinforcement spacing rigidity classification, and static pressure. Include any information required to demonstrate that the system has been coordinated and functions properly as a unit on the drawings and show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Submit function designation of the equipment and any other requirements specified throughout this section with the shop drawings. At termination of work, the Contractor and each major Subcontractor, as it applies to his work, shall submit 3 paper copies and an electronic copy of as-built drawings. As-built drawings to clearly show any field made changes to the original design.
SECTION 01 42 00 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

D. The addresses of the standards publishing organizations whose documents are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided. Documents listed in the specifications with numbers which were not assigned by the standards producing organization should be ordered from the source by title rather than by number.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
1819 L Street, NW, 6th Floor
Washington, DC 20036
Ph: 202-293-8020
Fax: 202-293-9287
E-mail: info@ansi.org
Internet: http://www.ansi.org/

AMERICAN WELDING SOCIETY (AWS)
550 N.W. LeJeune Road
Miami, FL 33126
Ph: 800-443-9353 - 305-443-9353
Fax: 305-443-7559
E-mail: info@aws.org or customerservice@awspubs.com
Internet: http://www.aws.org
REFERENCES

ASME INTERNATIONAL (ASME)
Three Park Avenue, M/S 10E
New York, NY 10016-5990
Ph: 800-854-7179 or 800-843-2763
Fax: 212-591-7674
E-mail: infocentral@asme.org
Internet: http://www.asme.org

ASTM INTERNATIONAL (ASTM)
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428-2959
Ph: 610-832-9585
Fax: 610-832-9555
E-mail: service@astm.org
Internet: http://www.astm.org

COPPER DEVELOPMENT ASSOCIATION (CDA)
260 Madison Avenue
New York, NY 10016
Ph: 212-251-7200
Fax: 212-251-7234
E-mail: questions@cda.copper.org
Internet: http://www.copper.org

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)
1901 North Moore Street
Arlington, VA 22209-1762
Ph: 703-525-1695
Fax: 703-528-2148
E-mail: isea@safetyequipment.org
Internet: http://www.safetyequipment.org/

INTERNATIONAL CODE COUNCIL (ICC)
5360 Workman Mill Road
Whittier, CA 90601
Ph: 1-888-422-7233
Fax: 562-908-5524
E-mail: webmaster@icc safe.org
Internet: www.iccsafe.org

NACE INTERNATIONAL (NACE)
1440 South Creek Drive
Houston, TX 77084-4906
Ph: 281-228-6200
Fax: 281-228-6300
E-mail: firstservice@nace.org
Internet: http://www.nace.org

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
1300 North 17th Street, Suite 1752
Rosslyn, VA 22209
Ph: 703-841-3200
Fax: 703-841-5900
Internet: http://www.nema.org/
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
1 Batterymarch Park
Quincy, MA 02169-7471
Ph: 617-770-3000 or 800-344-3555
Fax: 617-770-0700
E-mail: webmaster@nfpa.org
Internet: http://www.nfpa.org

NSF INTERNATIONAL (NSF)
789 North Dixboro Road
P.O. Box 130140
Ann Arbor, MI 48113-0140
Ph: 734-769-8010 or 800-NSF-MARK
Fax: 734-769-0109
E-mail: info@nsf.org
Internet: http://www.nsf.org

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)
400 Commonwealth Drive
Warrendale, PA 15096-0001
Ph: 724-776-4970
Fax: 724-776-0790
E-mail: customerservice@sae.org
Internet: http://www.sae.org

UNDERWRITERS LABORATORIES (UL)
2600 N.W. Lake Road
Camas, WA 98607-8542
Ph: 877-854-3577
Fax: 360-817-6278
E-mail: CEC.us@us.ul.com
Internet: http://www.ul.com/

U.S. ARMY CORPS OF ENGINEERS (USACE)
Order CRD-C DOCUMENTS from:
   Headquarters Points of contact
441 G Street NW
Washington, DC 20314-1000
Ph: 202-761-0011
E-mail: hq-publicaffairs@usace.army.mil
Order Other Documents from:
USACE Publications Depot
Attn: CEHEC-IM-PD
2803 52nd Avenue
Hyattsville, MD 20781-1102
Ph: 301-394-0081
Fax: 301-394-0084
E-mail: pubs-army@usace.army.mil
Internet: http://www.usace.army.mil/publications
   or http://www.hnd.usace.army.mil/techinfo/engpubs.htm
U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)  
Ariel Rios Building  
1200 Pennsylvania Avenue, N.W.  
Washington, DC 20004  
Ph: 202-272-0167  
for Fax and E-mail see below  
Internet: http://www.epa.gov  
--- Some EPA documents are available only from:  
National Technical Information Service (NTIS)  
5301 Shawnee Road  
Alexandria, VA 22312  
Ph: 703-605-6050 or 1-688-584-8332  
Fax: 703-605-6900  
E-mail: info@ntis.gov  
Internet: http://www.ntis.gov  

1.3 ABBREVIATIONS AND ACRONYMS  
A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. AABC - Associated Air Balance Council; www.aabc.com  
2. AAMA - American Architectural Manufacturers Association; www.aamanet.org  
3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org  
4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org  
5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org  
6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org  
7. ABMA - American Boiler Manufacturers Association; www.abma.com  
8. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org  
9. ACPA - American Concrete Pipe Association; www.concrete-pipe.org  
10. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org  
11. AF&PA - American Forest & Paper Association; www.afandpa.org  
12. AGA - American Gas Association; www.agag.org  
13. AHAM - Association of Home Appliance Manufacturers; www.aham.org  
15. AI - Asphalt Institute; www.asphaltinstitute.org  
16. AIA - American Institute of Architects (The); www.aia.org  
17. AISC - American Institute of Steel Construction; www.aisc.org  
18. AISI - American Iron and Steel Institute; www.steel.org  
19. AITC - American Institute of Timber Construction; www.aic-glulam.org  
23. APA - APA - The Engineered Wood Association; www.apawood.org  
24. APA - Architectural Precast Association; www.archprecast.org  
25. API - American Petroleum Institute; www.api.org
REFERENCES

26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
27. ARI - American Refrigeration Institute; (See AHRI).
29. ASCE - American Society of Civil Engineers; www.asce.org.
30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
32. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
33. ASSE - American Society of Safety Engineers (The); www.asse.org.
42. AWWA - American Water Works Association; www.awwa.org.
43. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
44. BIA - Brick Industry Association (The); www.gobrick.com.
46. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
47. BIISC - Baking Industry Sanitation Standards Committee; www.bissc.org.
48. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bissc.org.
49. CDA - Copper Development Association; www.copper.org.
50. CE - Conformite Europeenne; http://ec.europa.eu/growth/single-market/ce-marking/
51. CEA - Canadian Electricity Association; www.electricity.ca.
52. CEA - Consumer Electronics Association; www.ce.org.
54. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsesi.org.
56. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
59. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
61. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
63. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
64. CSA - Canadian Standards Association; www.csa.ca.
65. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csa-international.org.
66. CSI - Construction Specifications Institute (The); www.csinet.org.
68. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
69. CWC - Composite Wood Council; (See CPA).
71. DHI - Door and Hardware Institute; www.dhi.org.
72. ECA - Electronic Components Association; (See ECIA).
73. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
75. EIA - Electronic Industries Alliance; (See TIA).
78. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org.
79. ESTA - Entertainment Services and Technology Association; (See PLASA).
80. ETL - Intertek (See Intertek); www.intertek.com.
82. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
83. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
84. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
86. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
90. GA - Gypsum Association; www.gypsum.org.
92. GS - Green Seal; www.greenseal.org.
94. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
95. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
100. IAS - International Approval Services; (See CSA).
101. ICBO - International Conference of Building Officials; (See ICC).
103. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
104. ICRA - International Cast Polymer Alliance; www.icprb.org.
105. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
107. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
109. IESNA - Illuminating Engineering Society of North America; (See IES).
110. IEST - Institute of Environmental Sciences and Technology; www.ieset.org.
111. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
114. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
115. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
116. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
117. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
119. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
120. ITU - International Telecommunication Union; www.itu.int/home.
121. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
122. LMA - Laminating Materials Association; (See CPA).
REFERENCES

125. MCA - Metal Construction Association; www.metalconstruction.org.
134. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
139. NOAA - National Collegiate Athletic Association (The); www.ncaa.org.
140. NCMA - National Concrete Masonry Association; www.ncma.org.
142. NEECA - National Electrical Contractors Association; www.necanet.org.
144. NEMA - National Electrical Manufacturers Association; www.nema.org.
146. NFHS - National Federation of State High School Associations; www.nfhs.org.
148. NPPA - NFPA International (See NFPA).
151. NLGA - National Lumber Grades Authority; www.nlga.org.
152. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
154. NRCA - National Roofing Contractors Association; www.nrca.net.
159. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
161. PCI - Precast/Prestressed Concrete Institute; www pci.org.
162. PDI - Plumbing & Drainage Institute; www.pdionline.org.
163. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); http://www.plasa.org.
168. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
169. SDI - Steel Deck Institute; www.sdi.org.
170. SDI - Steel Door Institute; www.steeldoor.org.
171. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
172. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
175. SMA - Screen Manufacturers Association; www.smainfo.org.
176. SMACNA - Sheet Metal and Air Conditioning Contractors’ National Association; www.smacna.org.
177. SMPTE - Society of Motion Picture and Television Engineers; www.smp-te.org.
178. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
186. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
187. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
190. TIA - Telecommunications Industry Association Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
191. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
194. TPI - Turfgrass Producers International; www.turfgrasssod.org.
197. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
198. USAV - USA Volleyball; www.usavolleyball.org.
202. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
203. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
204. WDMA - Window & Door Manufacturers Association; www.wdma.com.
207. WWPA - Western Wood Products Association; www.wwpa.org.

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

1. DIN - Deutsches Institut fur Normung e.V.; www.din.de.
2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.

1. COE - Army Corps of Engineers; www.usace.army.mil.
3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.

Not to be used for bidding purposes

Bid Doc. No. 19-415
5. DOE - Department of Energy; [www.energy.gov](http://www.energy.gov).
6. EPA - Environmental Protection Agency; [www.epa.gov](http://www.epa.gov).
13. SD - Department of State; [www.state.gov](http://www.state.gov).
15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; [www.ars.usda.gov](http://www.ars.usda.gov).
17. USDOJ - Department of Justice; Office of Justice Programs; National Institute of Justice; [www.ojp.usdoj.gov](http://www.ojp.usdoj.gov).

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

2. FED-STD - Federal Standard; (See FS).
5. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).

F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION 01 42 00**
SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Demolition and removal of selected portions of building or structure.
   2. Demolition and removal of selected site elements.

1.3 DEFINITIONS
A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
B. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
C. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
D. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP
A. Unless otherwise indicated, demolition waste becomes property of Contractor.
B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
   1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 FIELD CONDITIONS
A. Owner will maintain operation of building throughout the construction process. Conduct selective demolition so Owner's operations will not be disrupted.
B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
C. Notify Owner of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

1.6 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner’s operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

B. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs, or video.

1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.

2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

3. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated on Drawings to be removed.
3.3 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent equipment and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary ventilation, heating, and cooling as specified on project drawings.

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

C. Remove temporary barricades and protections where hazards no longer exist.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials and contractor supplied monitoring equipment shows that the atmosphere is non-explosive and safe for workers. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
8. Dispose of demolished items and materials promptly.

B. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Owner, items may be removed to a suitable,
protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

E. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight to prevent corrosion to decking material.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by methods that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

3.7 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19
SECTION 07 01 50 – PREPARATION FOR RE-ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Roof surface examination.
   2. Demolition and removal of existing built-up roofing system.
   3. Temporary protection.
   4. Field quality control.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

B. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

C. Existing Roofing System: ballast rock, single-ply roofing membrane, roofing insulation, flashing, metal coping, wood nailer, and components and accessories between the existing concrete deck and the roofing membrane.

D. Roof Tear-Off: removal of Existing Roofing System as indicated on the drawings, and all underlayments.

1.4 SUBMITTALS

A. Provide a Work Plan that defines the means of managing precipitation while the old roofing is removed prior to the new roofing being installed.

B. Provide a schedule for existing roof removal and replacement.

1.5 MATERIAL OWNERSHIP

A. Unless otherwise noted, demolished materials shall become property of the Contractor and shall be removed from the Project site.
1.6 QUALITY ASSURANCE

A. Materials Removal Firm: See Section 07 54 23 “Thermoplastic-Polyolefin Roofing” for roofing contractor qualifications.

B. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Temporary Protection: Sheet polyethylene or fiber reinforced plastic tarpaulins; provide adequate weights to retain sheeting in place.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that existing roof surface is clean and ready for work of this section.

B. Proceed with roofing preparation only when weather conditions permit the work to proceed without water entering the building.

3.2 MATERIALS REMOVAL

A. Remove air unit and curbeds as outlined on the plans.

B. Remove lightning protection system as shown on the plans.

C. Remove existing metal copings and roof nailer from the top of all walls.

D. Remove flashings, vent flashings, and flashings around roof penetrations.

E. Remove ballast rock, single-ply roofing membrane, and roofing insulation down to the existing concrete decking to provide a clean working surface to receive the new roofing system.

F. Modify roof curbs as outlined in the plans. Patch existing roof penetrations with concrete decking as outlined in the plans.

G. Replace roof nailer with new wood nailer. Mechanically fasten to top brick course concrete curb.

H. Contractor shall clean and fully prepare the existing deck after removal of the existing roofing system. Prior to installing the roofing material the Contractor shall verify that the existing deck is suitable for the proposed roofing system.

3.3 TEMPORARY PROTECTION

A. Provide temporary protective sheeting over uncovered deck surfaces.

B. Provide weights or temporary fasteners to retain sheeting in position. Upon removal of the
C. Provide for surface drainage from sheeting to existing drainage facilities.

3.4 FIELD QUALITY CONTROL

A. Field inspection shall be performed daily by the Contractor and Owner.
B. Contractor shall notify the Owner in advance of roofing material removal to arrange for inspection of the existing roof decking. Inspections shall be performed jointly by the Contractor and Owner.

END OF SECTION 07 01 50
Not to be used for bidding purposes
SECTION 07 54 23 – THERMOPLASTIC POLYOLEFIN ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fully adhered Thermoplastic Polyolefin (TPO) roofing system.
2. Board roof insulation.
3. Membrane roof flashings, including base flashings and parapet flashings.
4. Elastomeric flashing boots at pipe penetrations.
5. Metal termination bars.
6. Walkway pads.

1.2 SUBMITTALS

A. Process all submittals as required in Section 013300 – Submittal Procedures.

B. Product Data: Submit roofing materials producer’s specifications, material characteristics and installation instructions for each product required including fasteners.

C. Certificates:

1. Submit copy of membrane producer’s approval of Installer.
2. Submit membrane producer’s letter, signed by an officer of the company, affirming that all construction documents have been reviewed, the materials proposed for use comply with the requirements of the construction documents and are acceptable to the company for issue of the warranties specified.
3. Submit certification that the roof system to be furnished has been tested and approved by Factory Mutual as a Class 1A roof system with 1-60 wind uplift resistance.
4. Submit list of foremen who have received factory training for installation of the system to be installed, along with kinds and dates of training.

D. Shop Drawings: Indicate:

1. Outline of roof and dimensions.
2. Typical and special details for flashings, roof curbs, penetrations, roof drains, perimeter conditions, termination details, etc. Reference the locations of details on the roof outline.
3. Number and mark of each factory prepared roofing sheet and flashing.
4. Fastener patterns for insulation and membrane edges at field, perimeter and corner conditions as required to meet design requirements for wind uplift resistance. Include copies of the applicable FM Approval Data pages as required to demonstrate compliance of installation with all FM requirements.

E. Test Strip Results:

1. Submit on a copy of the Shop Drawing plans marked to show where each test strip was cut to verify the integrity of the welded seams.
2. Upon Architect’s request submit the test strips taken, each identified for location and date taken.
1.3 QUALITY ASSURANCE

A. Roofing Contractor: Licensed in the State of Illinois, and specializing for at least 5 years in the type of membrane system involved, who is approved by Engineer and is certified/licensed by roofing membrane system producer and who can furnish for this installation a foreman factory trained by the roof membrane system producer.

B. Source of Supply: Membrane system materials shall be obtained from a single source of supply except as authorized otherwise by membrane producer.

C. Standards of Installation: All components of roof system shall be furnished and installed to meet wind resistance standards for a Class 1-60 roof as established in FM Data Loss Sheets 1-28 and 1-29.

D. Pre-Construction Conference: Roofing installers shall meet with Owner's representative and roof membrane producer's representative before construction begins to establish the techniques and methods required to complete roofing work as well as inspection criteria.

E. Membrane Producer's Inspection: Membrane producer's qualified inspector shall inspect roofing work during installation. Upon completion, he shall inspect work once again, in company with Owner's authorized representative, at time arranged by Roofing Contractor. Roofer shall pay all manufacturer's charges related to inspections.

1. As a minimum, the membrane producer shall inspect:
   a. Adhering of insulation.
   b. Adhering of membrane.
   c. Construction of seams and base flashings.
   d. Other critical points of construction as deemed necessary at the pre-construction conference.

2. Copies of record photographs and inspection reports shall be submitted.

F. Scheduling and Coordination:

1. Coordinate roofing installation with mechanical and electrical work associated with roof penetrations.
2. No phased construction will be considered or approved.

G. Wet and Damaged Materials: Shall not be installed.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Packaging: Deliver materials to the job site in their original containers or packages, sealed, with legible labels intact, brand name, lot number, warning labels and reference standards clearly shown.

B. Temperatures Prior to Use: Store materials in the dry and in accordance with membrane producer's instructions. Other than roof membrane, all materials furnished by membrane producer shall be stored between 60°F and 80°F. If exposed to lower temperatures, restore to 60 - 80°F prior to use.

C. Warped or Broken Insulation Boards: Shall be removed from site.
1.5 JOB CONDITIONS

A. Winds: Do not weld membrane when gusty winds or broken skies cause rapid fluctuations in ambient heat gain and heat loss.

B. Cold Weather: Follow membrane producer’s special recommendations when cold weather retards free flow of adhesives and sealants. Do not apply adhesives below adhesive manufacturers’ recommended ambient temperature ranges.

C. Electrical Power: Furnish power for heat welders by way of portable generator(s) producing at least 30 amps per welder supplied or at Contractor’s option, furnish power to 220V heat welders by way of #10 x 3 or greater power cords and boost the power with a step-up transformer when cord length exceeds 150 feet.

D. Fire Prevention: Take every precaution to prevent fire.
   1. Maintain at least 2 portable fire extinguishers, rated 10-B:C-20 pounds, near area where adhesives are being used and train applicators in their proper use.
   2. Do not use open flames to heat adhesives. Allow solvents to air-dry.
   3. Use only grounded spray equipment.

1.6 WARRANTIES

A. Roofing: Shall be provided with a non-prorated, No-Dollar-Limit, full system warranty to Owner, including insulation, against leaks or defects of any kind due to faulty materials or workmanship as follows.
   1. Roofing membrane system producer’s 15 year warranty for materials and workmanship.
   2. Roofing Contractor’s 15 year warranty for workmanship.

PART 2 – PRODUCTS

2.1 SYSTEM DESCRIPTION

A. System Fire Rating: Provide a fire-resistant membrane and insulation assembly which has been tested and listed by Underwriter’s Laboratories, Inc. (UL) as Class A or by Factory Mutual (FM) as Class 1A, for the roof decks and slopes to be used on this project.

B. System Wind Rating: Provide a membrane, flashing and insulation assembly that is currently listed by FM or UL to have a 30 psf wind uplift resistance rating, for example, FM 1-60.

C. System Hail Rating: Provide a membrane, flashing and insulation assembly that is currently listed by FM with a 1-SH hail resistance rating for the roof constructions indicated.

D. System Type: Reinforced thermoplastic olefin (TPO) membrane fully adhered to roof insulation which has been fully adhered to the roof deck.
   1. Approved Products: Use one of the following systems to the extent that it meets the requirements of this Section:
      (a) Firestone “UltraPly TPO”
      (b) Carlisle “Sure-Weld”
2.2 MATERIALS

A. Roof Membrane: A thermoplastic olefin (TPO) based on ethylene propylene cured rubber, .060" (60 mil) thick, reinforced with a fully encapsulated 10 x 10,000 denier polyester scrim, white color.

B. Roof Insulation: Rigid boards with HCHC-free isocyanurate foam core and glass fiber reinforced mat facers or organic/inorganic facers both sides.
   1. Use one of the following, as acceptable to membrane producer for a Class A rating:
      (a) Atlas “AC Foam II”
      (b) GAF “EnergyGuard ISO”
      (c) Firestone “ISO 95+”
      (d) Hunter “H-Shield”
   2. Thickness: For application in minimum 2 layers, one 2-1/2” and one 3” to a total typical system thickness of 5-1/2” or as otherwise shown on drawings, providing a minimum LTTR R of 5.5 per inch.
   3. Board Size: 4 ft x 4 ft maximum size for adhered boards.
   4. Tapered Insulation: Isocyanurate units by manufacturer of board insulation, tapered as required to achieve 1/8”/ft slopes except as otherwise indicated. No board shall be less than 3/4” thick.
   5. R-value: Minimum R-value shall be R-30.

C. Saddles and Crickets: Roof membrane manufacturer’s recommended fill, or additional tapered insulation installed on top or bottom of typical board insulation.

D. Mechanical Anchors: Types recommended by roof system manufacturer, including compression plates, for the kind of substrate indicated. Anchors shall feature anti-corrosive materials and anti-backout design.
   1. Approved Types: International Permalite Permafastener, Celotex Insulfast Nail/Disc or SFS Stadler’s TPR Peel Rivet.
   2. Anti-Corrosion Coating: Fasteners anchoring into wood shall bear zinc-free coatings.
   4. Lengths: Selected to penetrate at least 3/4” into top flute of steel deck, but not so long as to penetrate bottom flute.
   5. Fasteners for Termination Bars: Furnish fasteners with neoprene washers.

E. Insulation Adhesive: Any of the following, or equal, able to meet FM Class 1-90 requirements, as approved by Architect:
   1. Cold Adhesive: (Note that any costs applicable to establishing a cold adhesive as part of the roof warranty shall be deemed to have been included in any Bid Sum.)
      (a) “FAS-n-FREE” by Tremco Roofing.
      (b) “Insta-Stik” by Insta-Foam Products, Inc., Joliet, Illinois.
      (c) “Sure-Seal Fast 100” by Carlisle
2. Hot steep asphalt meeting ASTM D 312, Type III. (Note, Roofing Contractor may use steep asphalt ONLY WHEN THIS PRODUCT IS APPROVED AND INCLUDED AS A PART OF THE ROOFING MEMBRANE SYSTEM PRODUCER’S WARRANTY).

F. Base and Parapet Flashing: Same material as used for roof membrane.

G. Flashing To Cover Corners In Substrates and Secondary Flashings Over Termination Bars: Same material as roof membrane; or roof membrane producer’s unreinforced ethylene propylene-based flashing strips, .055” (55 mil) thick, of matching color.

H. Pipe Flashings: Premolded rubber boots approved by system producer for the membrane system, complete with stainless steel, screw tightened, pipe clamps.


I. Termination Bars: Aluminum bars with serrated backs as recommended by membrane system producer.

1. All exposed fasteners shall be installed with neoprene washers.

J. Metal Copings: Match existing dimensions and coloring. Materials shall be per Section 07 62 00 METAL FLASHINGS.

K. Walkway Pads: Types recommended by roof system manufacturer. Thickness shall be at least 0.150” (150 mil) thick, with tear strength of at least 100 lbf/in. Minimum of 30” width, white color. Provide walkway pads from roof hatch to each piece of roof mounted equipment.

L. Auxiliary Materials: Prefabricated flashing units, bonding adhesives, sealants, splicing cements, mastics and other accessory materials shall be as recommended by producer of roof membrane for the system installed.

PART 3 – EXECUTION

3.1 INSPECTION

A. Surfaces to Receive Roofing System: Verify that surfaces are suitable for application of materials and that wood nailers and saddles have been properly installed as required by Factory Mutual 1-90 requirements. Notify Engineer in writing of any unsuitable surfaces.

B. Acceptance of Conditions Affecting Application: Proceeding with roof system application shall designate acceptance of conditions.

3.2 INSULATION INSTALLATION

A. General: Lay insulation boards in 2 layers, with joints tightly butted and staggered at least 6” between adjacent rows and between layers.

1. Flatness: Do not allow difference in elevation between units at joints to exceed 1/16”.

Bid Doc. No. 19-415 07 54 23 - 5
2. Cuts: Straight or mitered, as required for adjoining faces to mate tightly.
4. Extent of Application: No more insulation shall be placed than can be covered with roofing membrane before the end of the day’s work or before onset of inclement weather.
5. Adhesives: Shall be applied only to clean, dry surfaces.

B. Crickets and Saddles: Slopes less than 1/8" per foot in the field of the roof, before and after maximum loading, shall not be accepted. Assure positive drainage flow by installing crickets and saddles wherever flow of rain water is obstructed, inadequate or must be positively encouraged during storms to counter the forces of excessive runoff speeds or high winds. Take special care to correct flow patterns at rooftop equipment.

3.3 ROOF MEMBRANE INSTALLATION

A. General: Install roofing membrane and flashings in accordance with details, specifications and best practices recommended by membrane producer. Follow all recommendations and comply with all precautions specified by roofing producer except that where conflict occurs between producer’s recommendations and these specifications, the more stringent requirement shall prevail.

1. Direction of Membrane Placement: Orient the membrane so that rainwater runs over rather than along lap joints.
2. Whole Sheets: Use whole, single sheets to the extent practicable.

B. Membrane Installation: Lay membrane in full bed of contact adhesive for 100% adhesion.

1. Relaxing: Roof membrane shall be set in place over substrate without stretching and allowed to relax 30 minutes before bonding.
2. Placement: Set sheets in final position, free of wrinkles and folds, overlapping adjacent sheets, with up-hill sheet on top of joint. Make overlap 2–1/2" on TPO membranes. Then roll sheet back evenly onto itself. Remove bonding contaminants from mating surfaces.
3. Bonding Adhesive Application: Apply evenly to underside of sheet and to insulation at about the same time so as to allow matching drying times. Smooth out adhesive with nap roller. Hold bonding adhesive well back from edges to be spliced over other membrane.
4. Bonding to Insulation: When bonding adhesive is tacky and does not stick or string to touch of a dry finger, roll membrane into the coated substrate slowly and evenly so as not to cause wrinkles. Compress the bond with an approved roller. Do not bond surfaces before adhesive becomes tacky. Should adhesive loose its tackiness, reapply adhesive. Set the pace of work accordingly. When first half of a sheet is fully adhered, complete other half in same manner.
5. Contaminated Adhesive: Should adhesive become contaminated by dust, moisture, walking etc., re-apply adhesive, but only after contaminated adhesive is thoroughly dry, even if redoing entire field of adhesive is required. Remove contaminated adhesives when so recommended by membrane producer.

C. Lap Splices:

1. Seams: Shall be field hot air welded with properly maintained and calibrated welding equipment, according to best practice, after thoroughly cleaning mating surfaces.
2. Exposed Scrim: Apply sealer over any edges that expose membrane’s reinforcing scrim.

D. Edge Attachment: Mechanically attach edges of membrane all around roof edges and roof openings, anchoring into parapets, using concrete anchors and bonding plates and/or termination strips according to membrane producer’s recommendations and approved details.

E. Flashing and Metal Copings: Bond only to clean surfaces. Contour the membrane to fit substrate to which it is bonded so as not to allow bridging or gapping effect.
1. Roof Interruptions, Curbs and Edges: Flash with longest pieces practicable. Terminate flashings a minimum of 8" above adjacent roof surface unless indicated otherwise.
2. Pipe Penetrations: Flash with prefabricated rubber boots. Seal the top of boots with stainless steel strap clamps and continuous bed of mastic sealant. Form all surfaces so as to provide positive drainage.
3. Pipe Clusters and Other Unusual Penetrations: Seal according to Architect's approval using sealant pockets having proper metal flashings all around.
4. Base Flashings: Membrane flashings applied over upright surfaces shall be fully adhered to substrate, all across contact area, using techniques similar to those used to bond main roof membrane.
5. Termination Bars: Fasten bars a maximum of 12" o.c. and within 2" of ends of units, using neoprene washered fasteners appropriate to substrate. Allow expansion space between units of 3/16" when metal temperature is 70°F or below and 1/8" when above 70°F.
6. Joints In Membrane Flashings: Provide a minimum lap of 3" at joints and compress the bond with an approved roller. Round off membrane corners. Apply additional patches of flashing membrane over joints and seal all around edges, according to roof membrane system producer's recommendations.
7. Flashing Over Fasteners: Cover the fasteners with flashing membrane, providing a minimum lap of 3" beyond washers.
8. Metal Copings: Install over wood nailer to match existing configuration. Match color and dimensions to existing copings.

F. Walkway Pads: Ensure membrane surface is clean, completely dry, and free of debris prior to installation. Install in 10' lengths, leaving a minimum of 1" space between sections to allow for drainage. Adhere to membrane surface via adhesives, tape, or heat welding. Walkway pads shall be installed from the roof hatch to each roof mounted equipment unit and completely surrounding each equipment item.

G. Temporary Closures: Install as needed to prevent water from flowing beneath roof system during inclement weather.

1. Extent: The roof membrane shall be extended at least 2 feet past edge of roof insulation and a continuous layer of sealer applied onto substrate 12" wide along the membrane edge.
2. Sealing Edge: Firmly embed roof membrane into sealer and provide continuous pressure over the length of the cut-off, using lumber and other ballast, so as to prevent blow-off.

H. Repairs:

1. Wrinkles: When within 18" of a splice or running towards a splice or positioned to interrupt proper drainage, cut out the wrinkle and repair with unspliced roof membrane to at least 3" beyond the wrinkle.
2. Cuts and Punctures: Patch over with roof membrane to at least 3" beyond the break.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Workmanship Quality Control Program: Maintain TPO roof membrane system manufacturer's program throughout the TPO installation, except as follows:

1. Seams: Probe ALL lap edges with approved tool and repair all edges which accept the probe; AND cut out and test no less than 1 cross strip of seam immediately after each startup of heat welder, including startups after break times, and major changes in weather. Take additional cuts at irregular areas, T-joints and hand-welded areas.
2. Records of Tests: Save the test strips and label each one with date and time of test. Indicate on a copy of Shop Drawing plans where each test strip was cut, and submit a copy of test locations to Architect.

B. Calibration: Do not begin welding with robot welders until tests on membrane scraps have established the correct temperature, welder weight and speed of application necessary for consistent, strong and continuous welds.

3.5 CLEAN UP

A. Smears and Droppings: Clean from all non-roofing surfaces.

B. Rubble, Debris, and Excess Materials: Remove roof construction rubble, debris, and excess roofing materials and containers.

END OF SECTION 07 54 23
SECTION 07 62 00 – METAL FLASHINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flashings and sheet metal work not specifically included with other Sections of the Specifications but required to prevent penetration of water through exterior shell of building.
2. Sealant for lap joints in runs of sheet metal flashings and for mounting cleats.

1.2 SUBMITTALS

A. Process all submittals as required in Section 013300 – Submittal Procedures.

B. Shop Drawings: Show materials, profiles, thicknesses, reinforcements, locations of work, jointing patterns, terminations, methods of installation and anchorages.

1. Outline of roof and dimensions.
2. Typical and special details for flashings, roof curbs, penetrations, roof drains, perimeter conditions, termination details, etc. Reference the locations of details on the roof outline.
3. Number and mark of each factory prepared roofing sheet and flashing.
4. Fastener patterns for insulation and membrane edges at field, perimeter and corner conditions as required to meet design requirements for wind uplift resistance. Include copies of the applicable FM Approval Data pages as required to demonstrate compliance of installation with all FM requirements.

C. Certifications:

1. Submit 2 roof membrane producer’s certification that metal items to be furnished for roofing are acceptable for inclusion in roof system producer’s warranty.
2. Submit certification that metal and fastening system to be furnished has been tested and approved by Factory Mutual for 1-60 wind up-lift requirements.

D. Samples: Submit 2 complete sets of color options for District’s preliminary selection, using the specified finish on the same metal as will be used for the sheet metal flashing items. Submit 3 additional samples of each selected color, not less than 3” x 5”, for District’s final selection.

1. Outline of roof and dimensions.
2. Typical and special details for flashings, roof curbs, penetrations, roof drains, perimeter conditions, termination details, etc. Reference the locations of details on the roof outline.
3. Number and mark of each factory prepared flashing.
4. Fastener patterns for insulation and membrane edges at field, perimeter and corner conditions as required to meet design requirements for wind uplift resistance. Include copies of the applicable FM Approval Data pages as required to demonstrate compliance of installation with all FM requirements.
1.3 WARRANTIES
A. Pre-finished Metal Flashings: Furnish with written warranty covering color fade, chalking and film integrity for 20 years.

1.4 QUALITY ASSURANCE
A. Fabrication: Work shall be water and weather-tight work, with surfaces free from waves and buckles, and seams avoided as much as possible.


C. Applicator: A company specializing in sheet metal flashing work and approved by membrane roofing subcontractor having 10 years’ minimum experience.

D. Coordination:
1. Roofing: Coordinate fabrication and installation of metal roof flashings with roof membrane system installers so as to meet requirements of roof warranty (specified in roofing specifications Section).
2. Adjoining Work: Coordinate metal flashings work with adjoining work for proper sequencing of each installation to ensure the best possible weather resistance and the protection of materials and finishes from damage.

F. Package and Delivery: Deliver prefinished sheet metal components free of surface blemishes.

PART 2 – PRODUCTS

2.1 METAL FLASHING MATERIALS
A. Basic Metal:
1. Galvanized Steel Sheet Commercial quality with 0.20% copper, meeting ASTM A 525/526 except A 527 for lock forming, with G90 hot-dip galvanized coating, 26-gauge (0.0179") except at indicated otherwise.

2. Exposed Surfaces Finish: Factory applied fluoropolymer coating containing a minimum of 70% by weight, Kynar 500, Kynar 500 VLD or Hylar 5000 resin; color as selected by Engineer from manufacturer’s full range of standard options.

2.2 FABRICATED SHEET METAL COMPONENTS
A. Sheet Metal Flashings & Roof Trim: As shown and detailed on drawings.

2.3 AUXILIARY MATERIALS
A. Flashing Cement: Asphalt mastic cement formulated for weathering and flow resistance, meeting requirements of Fed. Spec. SS-C-153

B. Adhesives: Type recommended by flashing sheet manufacturer for intended installation.

C. Dissimilar Metal Protection:
   1. Bituminous coating conforming to Fed. Spec. TT-C-494 or SSPC-Paint 12, or plastic separators, or insulating tape, subject to Architect’s approval.
   2. For metal flashing in contact with roofing, use separation materials or methods compatible with roofing system materials as approved by roofing system manufacturer.


E. Sealant for Metal Flashing Joints: Use one of the following, color as best blends with color of flashing material:
   1. Dap, inc. “Butyl-Flex”
   2. Pecora Corp. “BC 168”
   3. Protective Treatments, Inc. (PTI) “757 Butyl Sealant”
   4. Tremco “Butyl Sealant”
   5. Sonneborn Bldg. Products “Butakausk”

F. Nails and Fasteners:
   1. General: Use same metal for fastener as metal being attached. Nail heads shall be significantly larger than nailing slots in flashings.
   2. For Cleats to Nailers: Ring-shank or screw-shank long enough to penetrate wood nailer at least 1-3/4”, or #8 galvanized screws long enough to penetrate wood nailer 3/4”.
   3. For Fastening Galvanized Metal Flashings: Hot-dip galvanized nails of Stronghold type, with large, flat heads and shanks not smaller than No. 12 Stuffs Gauge (0.109”) and of sufficient length to penetrate wood blocking at least 7/8”.

2.4 FABRICATION

A. General: Fabricate all metal flashings necessary to provide complete leakproof conditions throughout the Work. Examine roof plans, details, sections and Mechanical Drawings to determine scope of sheet metal flashing work required.

   1. Workmanship: Make work weathertight, according to field measurements, formed true to detail, with sharply defined profiles, accurate in size, and free from distortion and defects. Do not use any techniques that will invalidate the warranty of precoated materials. Form pieces in longest lengths practical.
2. Expansion: Holes for fasteners shall be punched slots. Provide 4" end laps accurately fitted and firmly fastened in all continuous runs of sheet metal work, at intervals no more than 10'. Fill end laps with specified mastic.

3. Drip Edges: All exposed edges of flashing, except as specified otherwise, shall have 1/2" projecting hemmed edge.
   B. Seams: Form metal with cover plate seam.

PART 3 – EXECUTION

3.1 PREPARATION
A. Coordination with Other Trades: As required to provide flashings, etc. to secure their work.
B. Cleaning of Surfaces to be Covered: As required, removing dirt and other foreign matter.
C. Dissimilar Metals: Prepare all surfaces where dissimilar metals meet, using dissimilar metal protection materials hereinbefore specified.

3.2 INSTALLATION
A. General: Secure flashings in place using concealed fasteners. Use no exposed fasteners except as detailed. Install work watertight, making allowances for expansion and contraction. Install fasteners snug; do not over-tighten. Finished work shall be free of waves, warps, buckles, fastening stress, and distortions.

3.3 TOUCHUP
A. Damaged Sheet Metal Work: Repair or replace.
B. Finish: Minor damage to finish may be repaired in accordance with metal manufacturer’s recommendations. Engineer shall be final judge of acceptability of repairs to damaged finishes; replace sheet metal that cannot be repaired to satisfaction of Architect.

END OF SECTION 07 62 00
SECTION 07 72 00 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Provide and install factory-fabricated roof hatches and accessories for ladder access.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer’s product data.

B. Shop Drawings: Submit shop drawings including profiles, accessories, location, adjacent construction interface, and dimensions.

C. Warranty:

1.3 QUALITY ASSURANCE

A. Manufacturer: A minimum of 5 years’ experience manufacturing similar products.

B. Installer: A minimum of 2 years’ experience installing similar products.

C. Manufacturer’s Quality System: Registered to ISO 9001 Quality Standards including in-house engineering for product design activities.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver products in manufacturer’s original packaging. Store materials in a dry, protected, well-vented area. Inspect product upon receipt and report damaged material immediately to delivering carrier and note such damage on the carrier’s freight bill of lading.

1.5 WARRANTY

A. Manufacturer’s Warranty: Provide two-year full warranty on materials and workmanship from date of acceptance, per the Contract Agreement. Should a part fail to function in normal use within this period, manufacturer shall replace the part at no charge.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Type S Roof Hatch by The BILCO Company, P.O. Box 1203, New Haven, CT 06505, 1-800-366-6530, www.bilco.com.

C. Comparable products by JL Industries or Lane-Aire.

2.2 ROOF HATCH

A. Furnish and install where indicated on plans metal roof hatch, size 30" length x 36" width. Length denotes hinge side. The roof hatch shall be single leaf. The roof hatch shall be pre-assembled from the manufacturer.

B. Performance characteristics:

1. Cover shall be reinforced to support a minimum live load of 40 psf with a maximum deflection of 1/150th of the span and a 140 psf wind uplift.
2. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
3. Operation of the cover shall not be affected by temperature.
4. Entire hatch shall be weather tight with fully welded corner joints on cover and curb.

C. Cover: Shall be 11-gauge (0.0907") aluminum with a 3" beaded flange with formed reinforcing members. Cover shall have a heavy extruded EPDM rubber gasket that is bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.

D. Cover insulation: Shall be glass fiber board of 1" thickness, fully covered and protected by a metal liner minimum of 18-gauge aluminum (0.0403")

E. Curb: Shall be 12" in height and of 11-gauge (0.0907") aluminum. The curb shall be formed with a 3-1/2" flange with 7/16" holes provided for securing to the concrete roof deck. The curb shall be equipped with an integral metal cap-flashing of the same gauge and material as the curb, fully welded at the corners including stamped tabs, 6" on center, to be bent inward to hold single ply roofing membrane securely in place. Curb and cap-flashing shall be structurally designed to support a clamp/bolt connected hatch rail system.

F. Curb insulation: Shall be rigid, high-density fiberboard of 1" thickness, and fully encapsulated.

G. Lifting mechanisms: Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe welded to the curb assembly.

H. Hardware

1. Heavy pintle hinges shall be provided
2. Cover shall be equipped with a spring latch with interior and exterior turn handles
3. Roof hatch shall be equipped with an interior padlock hasp.
4. The latch strike shall be a stamped component bolted to the curb assembly.
5. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a 1" diameter vinyl covered grip handle, to permit easy release for closing.
6. Compression spring tubes shall be an anti-corrosive composite material and all other hardware shall be Type 316 stainless steel hardware.
7. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.

I. Finishes: Factory finish shall be mill finish aluminum.

J. Ladder Assist Post
1. Provide and install a standard product that will attach to the existing roof access ladder and will project 42” above the top ladder rung. The top 2 ladder rungs are 1” diameter and are spaced 13” center to center.
2. The post shall lock into position when fully extended and shall have a release mechanism that will return the post to fully retracted position. The mechanism shall be easy to operate while on the roof access ladder.
3. The post shall be manufacturer’s standard (1-1/4” inside diameter minimum acceptable) schedule 40 pipe or tube constructed from aluminum alloy 6061 T6.
4. All hardware shall be Type 316 stainless steel.

K. Hatch Rail System
1. The roof hatch shall be equipped with a rail system that attaches to the curb and protects the three sides that are open when the hatch is in the open position. The hinge side of the hatch is assumed to be secured when the hatch is open. System shall be in compliance with 29 CFR 1910.23, Code of Federal Regulations.
2. The ladder side shall be equipped with a self-closing swing gate that uses stainless steel spring hinges. The stainless steel gate latch shall be easily accessible and operable while on the access ladder.
3. Top of the rails shall be designed and installed to be 42” above the finished roof deck. There shall be 2 rails.
4. The rails shall be 1-1/4” diameter schedule 40 pipe constructed from aluminum alloy 6061 T6.
5. All edges shall be smooth and adequately enclosed from the elements. The finished product shall be powder coated with a safety yellow paint system.
6. Weep holes shall be on the underside, out of view.
7. All hardware materials shall be Type 316 stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates and openings for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install products in strict accordance with manufacturer’s instructions and approved submittals. Locate unit level, plumb, and in proper alignment with adjacent work.
1. Clean, lubricate, test units for proper function, and adjust operating mechanisms until proper operation is achieved.
2. Attached safety railing system to roof hatch curb according to manufacturer's instructions.
3. Attach ladder-assist post according to manufacturer’s instructions.
4. Repair finishes damaged during installation.

3.3 ADJUSTING AND CLEANING

A. Clean exposed surfaces using methods acceptable to the manufacturer and which will not damage finish.

END OF SECTION 07 72 00
PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency’s illustration for a particular penetration firestopping system, submit illustration with modifications marked, approved by penetration firestopping system manufacturer’s fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.3 INFORMATIONAL SUBMITTALS
A. Product test reports.

1.4 CLOSEOUT SUBMITTALS
A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."
PART 2 - PRODUCTS

2.1 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. 3M Fire Protection Products.
   c. Hilti, Inc.
   d. Specified Technologies, Inc.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
   2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
   3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.

F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

C. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.

   1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

D. Install fill materials by proven techniques to produce the following results:

   1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
   2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
   3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.2 FIELD QUALITY CONTROL

A. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

B. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION 07 84 13
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Silicone joint sealants.
   2. Nonstaining silicone joint sealants.
   3. Urethane joint sealants.
   4. Immersible joint sealants.
   5. Silyl-terminated polyether joint sealants.
   7. Polysulfide joint sealants.
   8. Butyl joint sealants.
   9. Latex joint sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples for Initial Selection: Manufacturer’s color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer.
1.5 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.
   1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
   1. Locate test joints where indicated on Project or, if not indicated, as directed by owner.
   2. Conduct field tests for each kind of sealant and joint substrate.
   3. Report whether the sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
   4. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.7 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: Match existing finishes.

2.2 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.

2.3 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C 1248.

B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.

2.4 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Uses T and NT.

2.5 IMMERSIBLE JOINT SEALANTS

A. Immersible Joint Sealants. Suitable for immersion in liquids; ASTM C 1247, Class 1; tested in deionized water unless otherwise indicated.
B. Urethane, Immersible, S, NS, 100/50, NT, I: Immersible, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Uses NT, and I.

2.6 Silyl-Terminated Polyether (STPE) Joint Sealants

A. STPE, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, silyl-terminated polyether joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. BASF Corporation; Construction Systems.
      b. GE Construction Sealants; Momentive Performance Materials Inc.
      c. Pecora Corporation.

2.7 Mildew-Resistant Joint Sealants

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. STPE, Mildew Resistant, S, NS, 50, NT: Mildew-resistant, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, silyl-terminated polyether joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.

2.8 Polysulfide Joint Sealants

A. Polysulfide, M, P, 25, T, NT: Multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, polysulfide joint sealant; ASTM C 920, Type M, Grade P, Class 25, Uses T and NT.

2.9 Butyl Joint Sealants

A. Butyl-Rubber-Based Joint Sealants: ASTM C 1311.

   1. Manufacturers: Subject to compliance with requirements, provide products by the following:

      a. Bostik, Inc.

2.10 Latex Joint Sealants

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade F.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Franklin International.
2.11 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Alcot Plastics Ltd.
   b. BASF Corporation; Construction Systems.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin or Type B (bicellular material with a surface skin, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.12 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
   a. Concrete.
   b. Masonry.
   c. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.

4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
   a. Metal.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.
   4. Provide flush joint profile according to Figure 8B in ASTM C 1193.
   5. Provide recessed joint configuration of recess depth and at according to Figure 8C in ASTM C 1193.
      a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
   1. Extent of Testing: Test completed and cured sealant joints.
      a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
   3. Inspect tested joints and report on the following:
      a. Whether sealants filled joint cavities and are free of voids.
      b. Whether sealant dimensions and configurations comply with specified requirements.
      c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
   4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING
A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION
A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE
A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
   1. Joint Locations:
      a. Isolation and contraction joints in cast-in-place concrete slabs.

   1. Joint Locations:
      b. Control and expansion joints in unit masonry.
      c. Joints in exterior insulation and finish systems.
   2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.

C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
   1. Joint Locations:


1. Joint Locations:
   a. Control and expansion joints on exposed interior surfaces of exterior walls.
   b. Vertical joints on exposed surfaces of unit masonry walls.
2. Joint Sealant: Urethane, S, NS, 25, NT.

E. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:
   a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.

END OF SECTION 07 92 00
SECTION 08 62 00 - SKYLIGHTS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Provide and install factory-fabricated skylights with accessories, as indicated on the drawings and herein.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer’s product data for each standard and custom skylight required on this project.

B. Shop Drawings: Submit shop drawings including dimensions, profiles, accessories, adjacent construction interface, and dimensions.

C. Warranty: Provide warranty certificate per Contract Agreement.

1.3 QUALITY ASSURANCE

A. Manufacturer: A minimum of 5 years’ experience designing and manufacturing similar products.

B. Installer: A minimum of 2 years’ experience installing similar products.

C. Manufacturer’s Quality System: Registered to ISO 9001 Quality Standards including in-house engineering for product design activities.

D. Fire test response characteristics, UL tested, for plastic sheets identical to those tested for the following requirements:

1. Self-ignition temperature of at least 650 degrees Fahrenheit when identical thickness and material plastic sheets are tested in accordance with ASTM D 1929.

2. Smoke density of 75 or less per ASTM D 2843 tested on identical thickness and materials plastic sheets.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver products in manufacturer’s original packaging. Store materials in a dry, protected, well-vented area. Inspect product upon receipt and report damaged material immediately to delivering carrier and note such damage on the carrier’s freight bill of lading.

1.5 WARRANTY

A. Manufacturer’s Warranty: Provide five-year full warranty on materials and workmanship from date of acceptance. This warranty shall be provided by the skylight manufacturer and is separate from the project’s 2-year warranty required per the Contract Agreement. Should a
skylight fail to function in normal use within this period, manufacturer shall replace the skylight at no charge.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Wasco Skylights, Part of the VELUX Group, Wells, ME.

B. Approved equal manufacturers meeting the quality assurance requirements above.

2.2 SKYLIGHTS

A. General: Factory-assembled, curb-mounted unit consisting of plastic glazing, gasketing, inner frame designed to mount on separate curb, and self-contained flashing.

B. The skylights shall be equipped with an integral metal cap-flashing, fully welded at the corners including stamped tabs, 6" on center, to be bent inward to hold single ply roofing membrane securely in place.

1. Seven Type EcoSky3 CLC2 single dome curb mount configuration with aerogel filled multiwall construction, approximately 32" x 32"; Contractor to verify all dimensions.

2. Two (2) continuous vault type structural model custom skylights, one approximately 7'-6" x 8'-4" and one approximately 7'-6" x 9'-4"; Contractor to verify all dimensions. Skylight shall include standard rise with thermally efficient multi-wall panel construction and vertical ends.

3. Above are Wasco products, other manufacturer's products shall be at least a similar level of quality.

C. All skylights shall be designed to accommodate a 30 psf snow load.

D. Condensation Control: Fabricate skylight units with integral internal gutters and weeps to collect and dispose of condensation.

E. Outer Glazing: Dome thermoformed:

1. Acrylic: Acrylite® translucent (or equal).

F. Middle Glazing (for triple domes only): Thermoformed Dome:

1. Acrylic: Clear.

G. Inner Glazing: Thermoformed Dome:

1. Acrylic: translucent.

2.3 MATERIALS

A. Curb Frame: High performance PVC with minimum effective thickness of 0.060 inch (1.5mm). Provide integral condensation gutter system with corners fully welded for waterproof quality.
B. Retainer Frame: Extruded aluminum alloy 6063-T5 (min). ASTM B 221 (ASTM B 221 M) with minimum effective thickness of 0.60 inch (1.5 mm).

C. Plastic Sheets: Monolithic, formable, transparent (colorless) or translucent (white) sheets with good weather resistant.

D. Thermal Break: Fabricate skylight units with thermal chambered PVC.

E. Gaskets: Structural glazing tape to form adhesive bond between PVC curb and inner dome and between inner and outer dome. Butyl tape between outer dome and extruded aluminum retainer. Gaskets form an air and water impenetrable barrier between adjacent surfaces.

F. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other non-corrosive metal as recommended by manufacturer.

G. Framing components to be factory fit and assembled, with welded joints in the aluminum framing system.

H. Skylights to be designed and fabricated to drain condensation and moisture from the skylight.

I. Skylights to be designed and fabricated to accommodate outside ambient temperature range between -10 degrees Fahrenheit to +110 degrees Fahrenheit, with indoor room temperature approximately 80 degrees.

J. Aluminum Finishes For Glazing Retainer:
   1. Comply with NAAMM “Metal Finishes Manual” recommendations for application and designations of finishes.
   2. Kynar Fluoropolymer Two-Coat System: (70% PVDF) complying with AAMA 2605. Color selection by Owner; provide samples for selection.

2.4 ROOF CURBS

A. Curb: Each skylight shall mount to an existing reinforced concrete roof curb. The existing wood nailers shall be removed and replaced with new wood that is compatible with the skylight manufacturer’s installation recommendations. Any damage caused to the existing concrete curb while removing old nailers and installing new nailers shall be repaired.

B. Existing membrane, sealants, and insulation shall be replaced with the roofing material replacement.

C. Skylight installation shall be coordinated with the roofing replacement work. Skylight installation shall be performed by the roofing subcontractor.

D. The curb nailers shall be at least 3-1/2” wide and project at least 3” above the concrete curb.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roof openings and curbs for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after correcting any unsatisfactory conditions.

3.2 INSTALLATION

A. Install products in strict accordance with manufacturer's written instructions and approved submittals. Install level, plumb, in proper alignment with adjacent work, and so as not to leak.

1. Repair finishes damaged during installation.
2. Replace units that are damaged in shipment or during installation.

3.3 ADJUSTING AND CLEANING

A. Clean exposed surfaces using methods acceptable to the manufacturer and which will not damage finish.

B. Interior and exterior surfaces shall be cleaned after installation is completed.

END OF SECTION 08 62 00
SECTION 22 14 13 – STORM DRAINAGE PIPING AND SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION:
   A. Provide fixtures and piping for drain systems as indicated and specified.

1.02 RELATED WORK:
   A. Division 01: General Requirements
   B. Section 02 41 19: Selective Demolition

1.03 SUBMITTALS:
   A. Shop Drawings: Submit the following in accordance with Section 01 33 00 – SUBMITTAL PROCEDURES:
      1. Manufacturer’s specifications, catalog data, descriptive matter, illustrations, diagrams, etc.
      2. Bolts, anchor bolts, and nuts.

1.04 QUALITY ASSURANCE:
   A. Comply with the following codes and standards:
      1. State and local codes and requirements of Regulatory Agencies.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS:
   A. Drainage; soil, waste, roof and vent provide:
      1. For sizes 3-in. thru 15-in., polyvinylchloride (PVC) piping, Schedule 80, ASTM D1785, National Sanitation Foundation seal, with solvent welded pressure fittings ASTM D2467.
      2. All pipe joints to be solvent cement welded with primer and cement that is compatible with the supplied piping.

2.02 INSULATION:
   A. Provide insulation in accordance with this Section.
   B. Insulate the following piping systems:
      1. Connections to roof drains.
      2. Horizontal roof drain piping.
3. First 2’ of vertical drop from the horizontal roof drain piping.

C. Pipe insulation (Type 1)

1. To include closed cell elastomeric insulation.
2. 1.5” required insulation thickness.
3. Minimum temperature range minus 40 degrees to plus 220 degrees Fahrenheit.
4. K factor at 75 degrees Fahrenheit not more than 0.27 BTU-inch/hour-square feet-degrees Fahrenheit.
5. Fire flame spread rating 25 or less.
6. Fire smoke density 50 or less.

D. Install per manufacturer’s recommendations with joints sealed with manufacturer recommended contact adhesive to form a continuous water barrier.

2.03 ROOF DRAINS:

A. Manufactured by: Josam Mfg. Co., Michigan City, IN; Zurn Industries, Inc., Erie, PA; Wade, Division of Tyler Pipe & Foundry Co., Tyler, TX; or acceptable equivalent product.

B. Provide roof drains with cast iron bodies and domes, complete with nonpuncture flashing clamp, integral stop and deck clamp, and 4-lb. sheet lead flashing.

Drain Schedule:

<table>
<thead>
<tr>
<th>Type</th>
<th>Manufacturer and Catalog Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof Drains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. I</td>
<td>Josam 21500 Wade W-3000 Zurn Z-100</td>
<td>Large sump and flashing flange and clamp, deck clamp bottom outlet, large low silhouette dome</td>
</tr>
</tbody>
</table>

2.04 ROOF DRAIN RUBBER BELLOWS:

A. Manufactured by Mercer Rubber – Style 31, Watts - Model RD900; Flexicraft Industries - DWV; or acceptable equivalent product.

B. Install between roof drain fitting and drain piping.

C. Neoprene rubber with resilient arches, wire hoop rings, and protective cover.

D. Provide Type 316 stainless steel worm drive clamps.

2.05 PAINTING:
A. Provide other ferrous surfaces not previously specified with one shop coat of Kop-Coat 622-LCF Primer made by Koppers Co., Inc., Pittsburgh, PA.; Series 37-77 Chem-Prime made by Tnemec Co., North Kansas City, MO; U-Prime 280 made by Porter International, Louisville, KY; or an acceptable equivalent product applied in accordance with the instructions of the manufacturer.

PART 3 - EXECUTION

3.01 PREPARATION:
A. Avoid interferences with other trades.

3.02 DEMOLITION:
A. Refer to Section 02 41 19 – Selective Demolition.
B. Demolish and remove existing piping system, roof drains, pipe insulation, pipe supports indicated to be replaced, and appurtenances as necessary to fulfill contract requirements.

3.03 INSTALLATION:
A. General:
1. Provide storm drainage piping. Make all connections for drain and waste piping.
2. Make piping connections to existing pipes and new drains to prevent excessive strain; install flexible connections as shown for roof drain connections.
B. Piping and Insulation:
1. Provide in accordance with the requirements indicated herein.
C. Drains: for roof drains extend 4-lb sheet lead flashing 8-in. from roof drain into membrane waterproofing or as recommended by the roof membrane manufacturer and/or roof membrane installer.

END OF SECTION 22 14 13
SECTION 23 01 30 - HVAC REFURBISHING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)


NORTH AMERICAN INSULATION MANUFACTURERS ASSOCIATION (NAIMA)

NAIMA AH112 (1993) Cleaning Fibrous Glass or Lined Sheet Metal Ducts
NAIMA AH127 (1999) Impact of Duct Cleaning on Internal Duct Insulation

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)


U.S. ARMY CORPS OF ENGINEERS (USACE)


U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 402-C-01-001 (2001) IAQ Building Education and Assessment Tool (I-BEAM)

UNDERWRITERS LABORATORIES (UL)

UL 181 (2013) Factory-Made Air Ducts and Air Connectors
UL 181B (2013) Standard for Closure Systems for Use with Flexible Air Ducts and Air Connectors

Not to be used for bidding purposes
1.2 DEFINITIONS

Perform the services specified here in accordance with the current published standards of the National Air Duct Cleaners Association (ACR and NADCA HVAC Inspection Manual).

1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Preconstruction Submittals
- Record of Existing Conditions
- Coordination Plan
- Product Data
  - Material Safety Data Sheets (MSDS)
- Test Reports
  - Testing Procedures Summary
- Post-Project Report

1.4 QUALITY CONTROL

A. Equipment, Materials and Labor

1. Possess and furnish all necessary equipment, materials and labor to adequately perform the specified services and comply with the applicable provisions of NADCA General Specifications for the Cleaning of Commercial HVAC Systems and ASHRAE 62.1.

a. Assure that all employees have received safety equipment training, medical surveillance programs, individual health protection measures, and manufacturer's product and Material Safety Data Sheets (MSDS) as required for the work by the U.S. Occupational Safety and Health Administration, and as described by this specification. For work performed in countries outside of the U.S.A., comply with applicable national safety codes and standards.

b. Maintain a copy of all current MSDS documentation and safety certifications at the site at all times, as well as comply with all other site documentation requirements of applicable OSHA programs and this specification.

c. Submit all Material Safety Data Sheets (MSDS) for all chemical products proposed used in the cleaning process, including all VOC ratings.

B. Licensing

1. Provide proof of maintaining the proper license(s), if any, as required to do work in the state of Illinois. Comply with all Federal, State and local rules, regulations, and licensing requirements.

C. Health and Safety

1. Safety Standards
a. Comply with all applicable Federal, State, and local requirements for protecting the safety of the contractors’ employees, building occupants, and the environment. In particular, follow all applicable standards of the Occupational Safety and Health Administration (OSHA) when working in accordance with this specification.

2. Occupant Safety

b. Employ no processes or materials in such a manner that introduce additional hazards into occupied spaces.

3. Disposal of Debris

c. Dispose of all debris removed from the HVAC System in accordance with applicable Federal, State and local requirements.

1.5 PROJECT/SITE CONDITIONS

A. Mechanical Drawings

1. Obtain one copy of the following documents:

   a. Project drawings and specifications including all addendum
   b. Approved construction revisions pertaining to the HVAC system

B. Site Conditions

1. The HVAC system includes air handlers of the facility’s fresh air distribution and exhaust system for spaces and/or occupied zones. This includes the entire heating, and ventilation system from the points where the air enters the system to the points where the air is discharged from the system. The air handling unit (AHU), the interior surfaces of the AHU, mixing box, coil compartment, fans, fan housing, fan blades, filters, filter housings, and heating coils are all considered part of the scope of work. The HVAC system may also include other components such as dedicated exhaust and ventilation components and make-up air systems.

PART 2 PRODUCTS

Provide all necessary motors, belts, filters, bearings, pulleys, tensioners, and other materials per the manufacturer’s replacement part schedule and project drawings.

2.1 MOTORS

A. Motors

1. Provide motors per equipment schedule and as specified in Section 23 05 13 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT.
PART 3 EXECUTION

Perform the services specified here in accordance with the current published standards of the National Air Duct Cleaners Association (ACR and NADCA HVAC Inspection Manual), established industry standards, and manufacturer’s instructions.

All terms in this specification have their meaning defined as stated in the NADCA Standards.

Follow NADCA Standards with no modifications or deviations being allowed. Remove visible surface contaminants and deposits from within the HVAC system in strict accordance with these specifications.

3.1 PREPARATION

A. HVAC System Inspections

1. HVAC System Evaluation

Prior to the commencement of any work, perform a visual inspection and checkout of the HVAC system in the presence of the owner’s representative to determine the appropriate methods, tools, and equipment required to satisfactorily complete this project.

Document damaged system components found during the inspection and submit to the owner, clearly labeled “Record of Existing Conditions.”

3.2 APPLICATION

A. General HVAC System Cleaning Requirements

1. Containment

   a. Collect debris removed during cleaning and take precautions to ensure that debris is not otherwise dispersed outside the HVAC system during the cleaning process.

2. Particulate Collection

   a. Where the Particulate Collection Equipment (PCE) is exhausting inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or greater). When the PCE is exhausting outside the building, undertake mechanical cleaning operations only with PCE, including adequate filtration to contain debris removed from the HVAC system. When the PCE is exhausting outside the building, take precautions to locate the equipment down wind and away from all air intakes and other points of entry into the building.

3. Controlling Odors

   a. Take all reasonable measures to control offensive odors and/or mist vapors during the cleaning process.

4. Component Cleaning
a. Employ cleaning methods such that all HVAC system components are Visibly Clean as defined in applicable standards. Upon completion, return all components to those settings recorded just prior to cleaning operations.

5. Air-Volume Control Devices

a. Mark the position of dampers and any air-directional mechanical devices inside the HVAC system prior to cleaning and, upon completion, restore to their marked position.

6. Service Openings

a. Utilize service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry, and inspection. Utilize the existing service openings already installed in the HVAC system where possible.
b. Create other openings where needed, created and resealed in conformance with NADCA Standard 05. Place closures so they do not significantly hinder, restrict, alter the air-flow within the system, or compromise the structural integrity of the system. Properly insulate closures to prevent heat loss/gain or condensation on surfaces within the system. Conform construction techniques used in the creation of openings to requirements of applicable building and fire codes, and applicable NFPA, SMACNA and NADCA Standards. Cutting service openings into flexible duct is not permitted. Disconnect flexible duct at the ends as needed for proper cleaning and inspection.
c. Reseal rigid fiber glass duct board duct systems in accordance with NAIMA recommended practices; NAIMA AH112, NAIMA AH122, and NAIMA AH127. Only closure techniques which comply with UL 181, UL 181A, or UL 181B are suitable for fiber glass duct system closures.
d. Clearly mark all service openings, capable of being re-opened for future inspection or remediation, and report their location in project report documents.

7. Air Handling Units

Ensure that supply fans and blowers are thoroughly cleaned. Areas for cleaning include blowers, fan housings, plenums (except ceiling supply and return plenums), scrolls, blades, or vanes, shafts, baffles, dampers and drive assemblies. Remove all visible surface contamination deposits in accordance with NADCA Standards.

a. Clean all air handling unit (AHU) internal surfaces, components and condensate collectors and drains.
b. Assure that a suitable operative drainage system is in place prior to beginning wash down procedures.
c. Clean all coils and related components.

B. Mechanical Cleaning Methodology

1. Source Removal Cleaning Methods

a. Clean the HVAC system using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. Select Source Removal methods which will render the HVAC System Visibly Clean and capable of passing NADCA cleaning verification methods Standards and other specified standards and tests, in accordance with all general requirements. Use no
cleaning method, or combination of methods, which could potentially damage components of the HVAC system or negatively alter the integrity of the system.

b. Completely remove any visible corrosion from metal surfaces, prime and paint to match existing. Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except clean to bare metal on metal surfaces subject to temperatures in excess of 120 degrees F. Apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Match existing or provide aluminum or light gray finish coat.

c. Incorporate the use of vacuum collection devices that are operated continuously during cleaning for all methods used. Connect a vacuum device to the downstream end of the section being cleaned through a predetermined opening. Use a vacuum collection device of sufficient power to render all areas being cleaned under negative pressure, such that containment of debris and the protection of the indoor environment is assured.

d. Equip all vacuum devices exhausting air inside the building, including hand-held vacuums and wet-vacuums, with HEPA filters (minimum efficiency).

e. Equip all vacuum devices exhausting air outside the facility with Particulate Collection including adequate filtration to contain Debris removed from the HVAC system, in a manner that does not allow contaminants to re-enter the facility. Release of debris outdoors which violates any outdoor environmental standards, codes or regulations is not allowed.

f. All methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods include those which will not potentially damage the integrity of the ductwork, nor damage porous surface materials such as liners inside the ductwork or system components.

2. Cleaning of Coils

a. Use any cleaning method which renders the coil visibly clean and capable of passing NADCA Coil Cleaning Verification Standards. Coil drain pans are subject to Non-Porous Surfaces Cleaning Verification. Maintain operability of the drain for the condensate at all times. Do not damage, displace, inhibit heat transfer, or cause erosion of the coil surface or fins, and conform to coil manufacturer recommendations when available. Thoroughly rinse coils with clean water to remove any latent residues.

3. Antimicrobial Agents and Coatings

a. Only apply antimicrobial agents if active fungal growth is reasonably suspected, or where unacceptable levels of fungal contamination have been verified through testing.

b. Perform application of any antimicrobial agents used to control the growth of fungal or bacteriological contaminants after the removal of surface deposits and debris.

c. Use only antimicrobial agents registered by the U.S. Environmental Protection Agency (EPA 402-F-91-102)(EPA 402-C-01-001) specifically for use within HVAC system.

d. Apply antimicrobial agents in strict accordance with manufacturer's instructions.

e. Use only antimicrobial coating products, for both porous and non-porous surfaces, which are EPA registered, water soluble solutions with supporting efficacy data and MSDS records.

C. Perform the following tests on hydronic coils:

1. Procedures in subparagraphs below are paraphrased from ASME B31.9.
2. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

3. While filling coils, use vents installed at high points to release air. Use drains installed at low points for complete draining of test liquid.

4. Subject hydronic coil to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks at no additional cost to owner.

6. Prepare written report of testing.

3.3 MAINTENANCE

A. General AHU System Maintenance Requirements

1. HVAC System Evaluation
   a. Prior to the commencement of any work, perform a complete operational checkout of the AHU in the presence of the owner's representative to determine the appropriate methods, tools, and equipment required to satisfactorily complete this project. Contractor to include all necessary parts and labor for refurbishing the existing air handlers.

B. Belts, Pulleys, and Tensioners

1. Contractor to determine the number of belts (if belt driven), belt lengths- measured at the pitch line (if belt driven), diameter of the drive sheave at the drive pitch line (if belt driven), and diameter of the driven sheave at the drive pitch line (if belt driven).

2. Replace all belts, pulleys and tensioners with new components. Tighten belts to proper tension. Ensure all components are properly aligned; adjust as needed.

3. Test V-belts and sheaves for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Uniformly load belts on drive side to prevent bouncing. Make alignment of direct driven couplings to within 50 percent of manufacturer's maximum allowable range of misalignment.

C. Filters

1. Contractor to determine the number of number and size of all filters; provide and replace per the district standards.

D. Bearings

1. Contractor to determine the number of number and size of shaft bearings; provide and replace per the district standards. Provide self-lubricating bearings (sealed-cassette ball bearing cartridges preloaded with grease) where possible.

E. Lubrication

1. Provide lubrication for all movable parts and related operating hardware in accordance with manufacturer's printed instructions and industry standard practice so that all parts operate smoothly and quietly without binding.
E. Motors

1. Replace existing motors with premium efficiency motors of horsepower and capacity equal to existing. Provide stainless steel mounting hardware for all components. See schedule on plans and Sections 23 05 13.

3.4 FIELD QUALITY CONTROL

A. Cleanliness Verification

1. General

   a. Verification of HVAC System cleanliness is determined after mechanical cleaning and before the application of any treatment or introduction of any treatment-related substance to the HVAC system, including antimicrobial agents and coatings.

   b. After completion, test each air handler to demonstrate proper operation at indicated and specified performance requirements including running, balance, noise, and airflow.

2. Visual Inspection

   a. Visually inspect the HVAC system to ensure that no visible contaminants are present.

   b. If no contaminants are evident through visual inspection, consider the HVAC system clean; however, further verification of the system cleanliness through gravimetric or wipe testing analysis testing may be requested at the discretion of the Contracting Officer.

   c. If visible contaminants are evident through visual inspection, re-clean those portions of the system where contaminants are visible, and subject to re-inspection for cleanliness.

2. Verification of Coil Cleaning

   a. Cleaning is to restore the coil pressure drop to within 10 percent of the pressure drop measured prior to cleaning and maintenance performed under this scope. If the original pressure drop is not known, the coil will be considered clean only if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection (see NADCA HVAC Inspection Manual Standards).

B. Post-Project Report

1. At the conclusion of the project, provide a Testing Procedures Summary and Post-Project Report indicating the following:

   a. Success of the cleaning project, as verified through visual inspection; provide photographs in the report documenting work.

   b. Areas of the system found to be damaged and the completed repairs for these components.

END SECTION 23 01 30
SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION
   A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
      1. Motor Controllers.
      2. Torque, speed, and horsepower requirements of the load.
      3. Ratings and characteristics of supply circuit and required control sequence.
      4. Ambient and environmental conditions of installation location.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product.

1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For motors to include in operation and maintenance manuals.

1.6 WARRANTY
   A. Warranty: Manufacturer agrees to repair or replace motors that fail in materials or workmanship within a 2 year warranty period.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS
   A. Comply with NEMA MG 1 unless otherwise indicated.
B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude up to 3000 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Premium efficiency.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class H.

J. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by manufacturer.
1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.

2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.

3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

D. Class I Division I rated where applicable.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 05 13
SECTION 23 05 17 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Sleeves.
   2. Stack-sleeve fittings.
   3. Sleeve-seal systems.
   4. Sleeve-seal fittings.
   5. Grout.

B. Related Requirements:

1. Section 07 84 13 PENETRATION FIRESTOPPING for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. CALPICO, Inc.

B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, anti-corrosion coated, with plain ends and integral welded waterstop collar.
D. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Metraflex Company (The).

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20-psig.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: Carbon steel or reinforced nylon polymer.
5. Connecting Bolts and Nuts: Type 316 Stainless Steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.

B. Description:

1. Manufactured plastic, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.
2. Plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.


C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.
PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

   Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.

   2. Cut sleeves to length for mounting flush with both surfaces.

      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

   3. Using silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

   1. Cut sleeves to length for mounting flush with both surfaces.

   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

   3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings as new walls and slabs are constructed.
B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using silicone sealant, seal space around outside of sleeve-seal fittings.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls Above Grade:
   a. Piping Smaller Than NPS 6: Steel pipe sleeves or Sleeve-seal fittings.
   b. Piping NPS 6 and Larger: Sleeve-seal fittings.

2. Exterior Concrete Walls Below Grade:
   a. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Steel pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs:
   a. Piping Smaller Than NPS 6: Steel pipe sleeves.
   b. Piping NPS 6 and Larger: Steel pipe sleeves.

4. Interior Partitions:
   a. Piping Smaller Than NPS 6: Steel pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION 23 05 17
SECTION 23 05 23 - BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. See Section 23 09 24 “Control Valves” for motor actuated valves.

1.2 SUMMARY

A. Section Includes:
   1. Brass ball valves.
   2. Bronze ball valves.
   3. Steel ball valves.
   4. Iron ball valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and weld ends.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.
PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded-end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B16.5 for flanges on steel valves.
   4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   6. ASME B31.1 for power piping valves.
   7. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Refer to HVAC valve schedule articles for applications of valves.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:
   1. Hand lever: For quarter-turn valves smaller than NPS 4.

H. Valves in Insulated Piping:
   1. Include 2-inch stem extensions.
   2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
   3. Memory stops that are fully adjustable after insulation is applied.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

A. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; Conbraco Industries, Inc.
      b. Crane; Crane Energy Flow Solutions.
      c. Hammond Valve.
      d. Jenkins Valves; Crane Energy Flow Solutions.
      e. Nibco.
      f. Milwaukee Valve Company.
Ball Valves for HVAC Piping

2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Forged brass.
   f. Ends: Threaded.
   g. Seats: PTFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

B. Brass Ball Valves, Three-Piece with Full Port and Stainless-Steel Trim:
   Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Jomar Valve.
   b. KITZ Corporation.
   c. Marwin Valve; Richards Industries.

2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Three piece.
   e. Body Material: Forged brass.
   f. Ends: Threaded.
   g. Seats: PTFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

2.3 Bronze Ball Valves
A. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
   Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; Conbraco Industries, Inc.
   b. Crane; Crane Energy Flow Solutions.
   c. Milwaukee Valve Company.
   d. NIBCO INC.

2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

B. Bronze Ball Valves, Three-Piece with Full Port Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; Conbraco Industries, Inc.
   b. Hammond Valve.
   c. Milwaukee Valve Company.
   d. NIBCO INC.

   2. Description:
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Three piece.
      e. Body Material: Bronze.
      f. Ends: Threaded.
      g. Seats: PTFE.
      h. Stem: Stainless steel.
      i. Ball: Stainless steel, vented.
      j. Port: Full.

C. Bronze Ball Valves, Three-Piece with Regular Port, and Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; Conbraco Industries, Inc.
   b. Jamesbury; Metso.

   2. Description:
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Three piece.
      e. Body Material: Bronze.
      f. Ends: Threaded and solder.
      g. Seats: PTFE.
      h. Stem: Stainless steel.
      i. Ball: Stainless steel, vented.
      j. Port: Regular.
2.4 STEEL BALL VALVES

A. Steel Ball Valves with Full Port and Stainless-Steel Trim, Class 150:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; Conbraco Industries, Inc.
   b. Jamesbury; Metso.

2. Description:
   d. Body Material: Carbon steel, ASTM A 216, Type WCB.
   e. Ends: Flanged.
   f. Seats: PTFE.
   g. Stem: Stainless steel.
   h. Ball: Stainless steel, vented.
   i. Port: Full.

B. Steel Ball Valves with Full Port and Stainless-Steel Trim, Class 300:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; Conbraco Industries, Inc.
   b. Jamesbury; Metso.

2. Description:
   b. CWP Rating: 720 psig.
   d. Body Material: Carbon steel, ASTM A 216, Type WCB.
   e. Ends: Flanged.
   f. Seats: PTFE.
   g. Stem: Stainless steel.
   h. Ball: Stainless steel, vented.
   i. Port: Full.

2.5 IRON BALL VALVES

A. Iron Ball Valves, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Apollo Valves; Conbraco Industries, Inc.
   c. Sure Flow Equipment Inc.

2. Description:
b. CWP Rating: 200 psig.
d. Body Material: ASTM A 126, gray iron.
e. Ends: Flanged.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel.
i. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 23 05 53 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

B. Select valves with the following end connections:
1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Brass or bronze ball valves, one or two piece with stainless-steel trim, and full port.
   1. Valves may be provided with solder-joint ends instead of threaded ends.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron ball valves, Class 125.
      a. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
   2. Steel ball valves, Class 150.

END OF SECTION 23 05 23
Not to be used for bidding purposes
SECTION 23 05 29 – HANGARS & SUPPORTS FOR HVAC PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Equipment supports.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details for components:

1. Trapeze pipe hangers.
2. Equipment supports.

1.4 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Type 316 Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

2.2 TRAPEZE PIPE HANGERS

A. Description: Shop- or field-fabricated pipe-support assembly made from type 316 stainless steel with type 316 stainless steel hanger rods, nuts, saddles, and U-bolts.

2.3 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.4 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.5 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars, black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from type 316 stainless steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer’s operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer’s written instructions.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.


G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.
3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use type 316 stainless steel pipe hangers and supports and metal trapeze pipe hangers and attachments for hostile environment applications (Screen Rooms).

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications (Screen Rooms).

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Type 316 Stainless Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.

4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with stainless steel-pipe base stanchion support.

7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and stainless steel floor flange or stainless steel plate, and with U-bolt to retain pipe.

8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:


2. Type 316 Stainless steel Riser Clamps: For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Type 316 stainless Steel Turnbuckles: For adjustment up to 6 inches for heavy loads.

2. Type 316 stainless Steel Clevises: For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

   a. Light (MSS Type 31): 750 lb.

   b. Medium (MSS Type 32): 1500 lb.

   c. Heavy (MSS Type 33): 3000 lb.

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29
SECTION 23 05 48 – VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Elastomeric hangers.
   2. Spring hangers.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ELASTOMERIC HANGERS
A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: HR, HD, HA-E, AVH, HB-E.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Isolation Technology, Inc.
      b. Mason Industries, Inc.
      c. Vibra Systems., Inc.
   2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
   3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.2 SPRING HANGERS
A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: W30, C1.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Mason Industries, Inc.
      b. Isolation Technology, Inc.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 VIBRATION CONTROL DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points.

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION 23 05 48
SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
1. Equipment labels.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS
A. Metal Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Brady Corporation.
   b. Carlton Industries, LP.
   c. Kolbi Pipe Marker Co.

2. Material and Thickness: stainless steel, 0.025-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.


4. Background Color: Black.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Brady Corporation.
   b. Carlton Industries, LP.
c. Kolbi Pipe Marker Co.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
4. Background Color: Black.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.
B. Locate equipment labels where accessible and visible.

END OF SECTION 23 05 53
SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:
   a. Constant-volume air systems.
   b. Variable-air-volume systems.

1.2 DEFINITIONS


C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.3 ACTION SUBMITTALS

A. TAB Report: Documentation indicating that Work complies with ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.4 INFORMATIONAL SUBMITTALS


B. Certified TAB reports.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC.

   1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
   2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.

B. TAB Specialists Qualifications: Certified by NEBB or TABB.
1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB as a TAB technician.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
J. Examine terminal units, such as unit heaters, and verify that they are accessible and their controls are connected and functioning.

K. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

L. Examine operating safety interlocks and controls on HVAC equipment.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures for balancing the systems.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

   1. Airside:
      a. Duct systems are complete with terminals installed.
      b. Volume, smoke, and fire dampers are open and functional.
      c. Clean filters are installed.
      d. Fans are operating, free of vibration, and rotating in correct direction.
      e. Variable-frequency controllers' startup is complete and safeties are verified.
      f. Automatic temperature-control systems are operational.
      g. Ceilings are installed.
      h. Windows and doors are installed.
      i. Suitable access to balancing devices and equipment is provided.

   2. Hydronics:
      a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
      b. Piping is complete with terminals installed.
      c. Systems are flushed, filled, and air purged.
      d. Strainers are pulled and cleaned.
      e. Control valves are functioning per the sequence of operation.
      f. Shutoff and balance valves have been verified to be 100 percent open.
      g. Pumps are started and proper rotation is verified.
      h. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
      i. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" ASHRAE 111, or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
   2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 "Air Duct Accessories".
   3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13 “Duct Insulation” and Section 23 07 19 “HVAC Piping Insulation”.

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) and metric (SI) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems’ "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louveres and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check for proper sealing of air-handling-unit components.

K. Verify that air duct system is sealed as specified in Section 23 31 13 “Metal Ducts” and 23 31 16 “Non Metal Ducts”.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure total airflow.
a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:
   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
   c. Measure static pressure across each component that makes up the air-handling system.
   d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

4. Obtain approval from Owner for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
   1. Measure airflow of submain and branch ducts.
   2. Adjust submain and branch duct volume dampers for specified airflow.
   3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.
   1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
   2. Measure inlets and outlets airflow.
   3. Adjust each inlet and outlet for specified airflow.
   4. Re-measure each inlet and outlet after they have been adjusted.

3.6 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
   2. Air Outlets and Inlets: Plus or minus 10 percent.
   3. Heating-Water Flow Rate: Plus or minus 10 percent.
   4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.
3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the building static pressure sensor is located.
2. Verify that the system is under static pressure control.
3. Calibrate and balance each fan for maximum and minimum design airflow as follows:
   a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
   b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
   c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
   d. Adjust controls so that terminal is calling for minimum airflow.
   e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.

4. After fans have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
   a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
   b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
   c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
   d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
   e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

5. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
   a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
   b. Verify that terminal units are meeting design airflow under system maximum flow.

6. Measure the building static pressure and adjust the systems to maintain the optimum building static pressure. Record set point and give to controls contractor.

7. Verify final system conditions as follows:
   a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
   b. Re-measure and confirm that total airflow is within design.
   c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
   d. Mark final settings.
   e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
   f. Verify tracking between supply and exhaust fans.
3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems’ "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
   1. Check liquid level in expansion tank.
   2. Check highest vent for adequate pressure.
   3. Check flow-control valves for proper position.
   4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
   5. Verify that motor starters are equipped with properly sized thermal protection.
   6. Check that air has been purged from the system.

3.9 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report’s binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.
   3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Fan curves.
   2. Manufacturers’ test data.
   3. Field test reports prepared by system and equipment installers.
   4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB specialist.
   3. Project name.
   4. Project location.
   5. Owner’s name and address.
   6. Engineer’s name and address.
   7. Contractor’s name and address.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report.
       Number each page in the report.
   11. Summary of contents including the following:

       a. Indicated versus final performance.
       b. Notable characteristics of systems.
       c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
   a. Settings for outdoor-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Fan drive settings including settings and percentage of maximum pitch diameter.
   d. Inlet vane settings for variable-air-volume systems.
   e. Settings for supply-air, static-pressure controller.
   f. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
   1. Quantities of outdoor, supply, return, and exhaust airflows.
   2. Water and steam flow rates.
   3. Duct, outlet, and inlet sizes.
   4. Terminal units.
   5. Balancing stations.

E. Fan Test Reports: For supply, return, and exhaust fans, include the following:
   1. Fan Data:
      a. System identification.
      b. Location.
      c. Make and type.
      d. Model number and size.
      e. Manufacturer's serial number.
      f. Arrangement and class.
      g. Sheave make, size in inches, and bore.
      h. Center-to-center dimensions of sheave and amount of adjustments in inches.
   2. Motor Data:
      a. Motor make, and frame type and size.
      b. Horsepower and rpm.
      c. Volts, phase, and hertz.
      d. Full-load amperage and service factor.
      e. Sheave make, size in inches, and bore.
      f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
      g. Number, make, and size of belts.
   3. Test Data (Indicated and Actual Values):
      a. Total airflow rate in cfm.
      b. Total system static pressure in inches wg.
      c. Fan rpm.
      d. Discharge static pressure in inches wg.
      e. Suction static pressure in inches wg.

F. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
   a. System and air-handling-unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Entering-water temperature in deg F.
   c. Leaving-water temperature in deg F.
   d. Water pressure drop in feet of head or psig.
   e. Entering-air temperature in deg F.
   f. Leaving-air temperature in deg F.

G. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System and air-handling-unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F.
   d. Duct static pressure in inches wg.
   e. Duct size in inches.
   f. Duct area in sq. ft.
   g. Indicated airflow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual airflow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

H. Instrument Calibration Reports:

1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

3.10 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Owner.

B. Owner shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:
   1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
   2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
   3. If the second verification also fails, Owner may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.11 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93
SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:
   1. Heating hot-water piping, indoors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail insulation application at pipe expansion joints for each type of insulation.
   4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Detail removable insulation at piping specialties.
   6. Detail application of field-applied jackets.
   7. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.
1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.6 COORDINATION

A. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   
a. Aeroflex USA, Inc.
b. Armacell LLC.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   
a. Johns Manville; a Berkshire Hathaway company.
b. Knauf Insulation.
c. Manson Insulation Inc.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Phenolic:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   
a. Kingspan Tarec Industrial Insulation NV.

2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.

3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.

4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

   
a. Preformed Pipe Insulation: ASJ.

J. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Duna USA Inc.
   b. Dyplast Products.
   c. Elliott Company of Indianapolis.

2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.

3. Flame-spread index shall be 25 or less, and smoke-developed index shall be 50 or less for thickness up to 1 inch as tested by ASTM E 84.

4. Fabricate shapes according to ASTM C 450 and ASTM C 585.

   a. Pipe Applications: ASJ-SSL.

### 2.2 INSULATING CEMENTS


B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.


### 2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand; H. B. Fuller Construction Products.
      b. Eagle Bridges - Marathon Industries.
      c. Foster Brand; H. B. Fuller Construction Products.

C. Phenolic and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Childers Brand; H. B. Fuller Construction Products.

D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Aeroflex USA, Inc.
b. Armacell LLC.
c. Foster Brand; H. B. Fuller Construction Products.

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand; H. B. Fuller Construction Products.
   b. Eagle Bridges - Marathon Industries.
   c. Foster Brand; H. B. Fuller Construction Products.

F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand; H. B. Fuller Construction Products.
   b. Eagle Bridges - Marathon Industries.
   c. Foster Brand; H. B. Fuller Construction Products.

G. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Dow Corning Corporation.
   b. Johns Manville; a Berkshire Hathaway company.
   c. P.I.C. Plastics, Inc.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.
   c. Knauf Insulation.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand; H. B. Fuller Construction Products.
   b. Eagle Bridges - Marathon Industries.
   c. Foster Brand; H. B. Fuller Construction Products.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand; H. B. Fuller Construction Products.
   b. Eagle Bridges - Marathon Industries.
   c. Foster Brand; H. B. Fuller Construction Products.
   d. Knauf Insulation.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 deg F.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand; H. B. Fuller Construction Products.
   b. Eagle Bridges - Marathon Industries.
   c. Foster Brand; H. B. Fuller Construction Products.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH
A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. in a Leno weave, for pipe.

2.8 FIELD-APPLIED CLOTHS
A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

2.9 FIELD-APPLIED JACKETS
A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Johns Manville; a Berkshire Hathaway company.
   b. P.I.C. Plastics, Inc.
   c. Proto Corporation.
2. Adhesive: As recommended by jacket material manufacturer.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. ITW Insulation Systems; Illinois Tool Works, Inc.

   a. Factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
   d. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
   a. Factory cut and rolled to size.
   b. Material, finish, and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
   d. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division.
      c. Knauf Insulation.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division.
      c. Knauf Insulation.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Compac Corporation.
   2. Width: 2 inches.
   3. Thickness: 6 mils.
   5. Elongation: 500 percent.
   6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Width: 2 inches.
3. Thickness: 3.7 mils.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.11 SECUREMENTS

A. Bands:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. ITW Insulation Systems; Illinois Tool Works, Inc.
   2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
   a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   5. Handholes.
   6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Section 07 84 13 "PENETRATION FIRESTOPPING for firestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 PENETRATION FIRESTOPPING.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

Not to be used for bidding purposes
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:
1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.10 INSTALLATION OF POLYISOCYANURATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
   2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
   3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.

C. Insulation Installation on Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of polyisocyanurate insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.11 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer’s recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer’s recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch-overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal for “fishmouthing,” and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.12 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and to match existing color.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer’s recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
D. Do not field paint aluminum or stainless-steel jackets.

3.13 FIELD QUALITY CONTROL
A. Perform tests and inspections.
B. Tests and Inspections:
   1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.14 PIPING INSULATION SCHEDULE, GENERAL
A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.15 INDOOR PIPING INSULATION SCHEDULE
1. NPS 12 and Smaller: Insulation shall be one of the following:
   a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick, minimum conductivity 0.25 to 0.29 BTU-In.
   b. Phenolic: 2 inches thick, minimum conductivity 0.25 to 0.29 BTU-In.
   c. Polyisocyanurate: 2 inches thick, minimum conductivity 0.25 to 0.29 BTU-In.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE
A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. If more than one material is listed, selection from materials listed is Contractor's option.
C. Piping, Exposed:
   1. PVC, Color-Coded by System: 20 mils thick.
   2. Stainless Steel, Type 304 or Type 316, Stucco Embossed: 0.020 inch thick.
SECTION 23 09 24 - CONTROL VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes control valves and actuators for DDC systems.

B. Related Requirements:
   1. Section 23 10 10 “Monitoring and Control System for HVAC” control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
   2. Section 23 09 93 “Sequence of Operations for HVAC”.

1.3 DEFINITIONS

A. Cv: Design valve coefficient.

B. DDC: Direct-digital control.

C. NBR: Nitrile butadiene rubber.

D. PTFE: Polytetrafluoroethylene

E. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:
   1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
   4. Installation, operation, and maintenance instructions, including factors affecting performance.
**B. Shop Drawings:**

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For control valves to include in operation and maintenance manuals.

### 1.6 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace valves and actuators that fail in materials or workmanship within a 2 year warranty period.

**PART 2 - PRODUCTS**

### 2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

C. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

D. Backup Power Source: Systems and equipment served by a backup power source shall have associated control valve actuators served from a backup power source.

E. Environmental Conditions:

   1. Provide electric control valve actuators, with protective enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Electric control valve actuators not available with integral enclosures, complying with requirements indicated, shall be housed in protective secondary enclosures.


F. Determine control valve sizes and flow coefficients by ISA 75.01.01.

G. Control valve characteristics and rangeability shall comply with ISA 75.11.01.

H. Selection Criteria:

   1. Control valves shall be suitable for operation at following conditions:
a. Heating Hot Water: 150 psi, 180 Deg F.

2. Control valve shutoff classifications shall be FCI 70-2, Class IV or better unless otherwise indicated.
3. Valve pattern, straight through, as indicated on Drawings.
4. Modulating straight-through pattern control valves shall have equal percentage flow-throttling characteristics unless otherwise indicated.
5. Modulating butterfly valves shall have linear flow-throttling characteristics.
6. Fail positions unless otherwise indicated:
   a. Heating Hot Water: Open.

7. Globe-type control valves shall pass the design flow required with not more than 95 percent of stem lift unless otherwise indicated.
8. Rotary-type control valves, such as ball and butterfly valves, shall have Cv falling between 65 and 75 degrees of valve full open position and minimum valve Cv between 15 and 25 percent of open position.
9. Selection shall consider viscosity, flashing, and cavitation corrections.
10. Valves shall have stable operation throughout full range of operation, from design to minimum Cv.
11. Minimum Cv shall be calculated at 10 percent of design flow, with a coincident pressure differential equal to the system design pump head.
12. In water systems, select modulating control valves at terminal equipment for a design Cv based on a pressure drop of 5 psig at design flow unless otherwise indicated.
13. Modulating control valves shall be line size unless otherwise indicated.

2.2 BALL-STYLE CONTROL VALVES

A. Ball Valves with Two Ports and Characterized Disk:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Belimo B3 Series.
2. Pressure Rating for NPS 1 and Smaller: Nominal 600 WOG.
3. Pressure Rating for NPS 1-1/2 through NPS 2: Nominal 400 WOG.
5. Process Temperature Range: Zero to 212 deg F.
7. End Connections: Threaded (NPT) ends.
9. Stem and Stem Extension:
   a. Material to match ball.
   b. Blowout-proof design.
   c. Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.
10. Ball Seats: Reinforced PTFE.
11. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means,
such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

13. Flow Characteristics for B-Port: Modified for constant common port flow.

2.3 SOLENOID VALVES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ASCO 8210 Series.

B. Description:

1. Action: Either normally open or normally closed in the event of electrical power failure as required by the application.
2. Size to close against the system pressure.
4. Heavy-duty assembly.
5. Body: Brass or stainless steel.
6. Seats and Discs: NBR or PTFE.
8. Voltage: 24-V ac.

2.4 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

A. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.

B. Position indicator and graduated scale on each actuator.

C. Type: Motor operated, with or without gears, electric and electronic.

D. Voltage: 24-V ac.

E. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.

F. Function properly within a range of 85 to 120 percent of nameplate voltage.

G. Construction:

1. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
2. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.
3. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

H. Field Adjustment:
1. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.

I. Modulating Actuators:

1. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
2. Control Input Signal:
   a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.
   b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10- or 4- to 20-mA signals.
   c. Programmable Multi-Function:
      1) Control Input, Position Feedback, and Running Time: Factory or field programmable.
      2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
      3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.

J. Position Feedback:

1. Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
2. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

K. Fail-Safe:

1. Where indicated, provide actuator to fail to an end position.
2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

L. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

M. Valve Attachment:

1. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve shaft without the need for connecting linkages.
2. Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

N. Temperature and Humidity:
1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, non-condensing.

O. Enclosure:
1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. Provide actuator enclosure with heater and control where required by application.

P. Stroke Time:
1. Operate valve from fully closed to fully open within 15 seconds.
2. Operate valve from fully open to fully closed within 15 seconds.
3. Move valve to failed position within 5 seconds.
4. Select operating speed to be compatible with equipment and system operation.

Q. Sound:
1. Spring Return: 62 dBA.
2. Non-Spring Return: 45 dBA.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for valves installed in piping to verify actual locations of piping connections before installation.
C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROL VALVE APPLICATIONS
A. Control Valves:
   1. Select from valves specified in "Control Valves" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

3.3 INSTALLATION, GENERAL
A. Furnish and install products required to satisfy most stringent requirements indicated.
B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support instruments, tubing, piping, wiring, and conduits to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment.

D. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Firestop penetrations made in fire-rated assemblies and seal penetrations made in acoustically rated assemblies.

F. Fastening Hardware:
   1. Stillson wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
   2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
   3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

G. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

H. Corrosive Environments:
   1. Use products that are suitable for environment to which they will be subjected.
   2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:
      a. Laboratory exhaust airstreams.
      b. Process exhaust airstreams.
   3. Use Type 316 stainless-steel tubing and fittings when in contact with a corrosive environment.
   4. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosion-resistant coating that is suitable for environment.
   5. Where control devices are located in a corrosive environment and are not corrosion resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 26 28 16 “Enclosed Switches and Circuit Breakers”.

C. Furnish and install power wiring. Comply with requirements in Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables”.

Bid Doc. No. 19-415

23 09 24 - 7
D. Furnish and install raceways. Comply with requirements in Section 26 05 33 “Raceways and Boxes for Electrical Systems”.

3.5 CONTROL VALVES

A. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

B. Install flanges or unions to allow drop-in and -out valve installation.

C. Valve Orientation:
   1. Where possible, install ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
   2. Install valves in a position to allow full stem movement.
   3. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.

D. Clearance:
   1. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
   2. Install valves with at least 12 inches of clear space around valve and between valves and adjacent surfaces.

E. Threaded Valves:
   1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
   2. Align threads at point of assembly.
   3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
   4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.

F. Flanged Valves:
   1. Align flange surfaces parallel.
   2. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.6 CONNECTIONS

A. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 26 05 26 “Grounding and Bonding for Electrical Systems”.

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at
points of connection. Comply with requirements for identification specified in Section 26 05 53 “Identification for Electrical Systems”.

B. Install engraved phenolic nameplate with valve identification on valve.

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.9 CHECKOUT PROCEDURES

A. Control Valve Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check valves for proper location and accessibility.
3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. For pneumatic products, verify air supply for each product is properly installed.
5. For pneumatic valves, verify that pressure gauges are provided in each air line to valve actuator and positioner.
6. Verify that control valves are installed correctly for flow direction.
7. Verify that valve body attachment is properly secured and sealed.
8. Verify that valve actuator and linkage attachment are secure.
9. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
10. Verify that valve ball, disc, and plug travel are unobstructed.
11. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.

C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

D. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 23 09 24
SECTION 23 09 25 - FLOW INSTRUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Airflow measuring devices.

B. Related Requirements:
   1. Section 23 10 10 "Monitoring and Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
   2. Section 23 09 93 "Sequence of Operations for HVAC Controls".

1.3 DEFINITIONS

A. Ethernet: Local area network based on IEEE 802.3 standards.

B. HART: Highway addressable remote transducer protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bi-directional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.

C. PEEK: polyetheretherketone.

D. PTFE: Polytetrafluoroethylene.

E. PPS: Polyphenylene sulfide.

F. RS-485: A TIA standard for multipoint communications using two twisted pairs.

G. RTD: Resistance temperature detector.

H. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:
1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
4. Installation instructions, including factors affecting performance.

B. Shop Drawings:
1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include diagrams for air and process signal tubing.
5. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

C. Delegated-Design Submittal:
1. Schedule and design calculations for flow instruments, including the following.
   a. Flow at Project design and minimum flow conditions.
   b. Pressure drop at Project design and minimum flow conditions.

1.5 INFORMATIONAL SUBMITTALS
A. Product Certificates: For each product requiring a certificate.
B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

1.7 WARRANTY
A. The warranty of this equipment is to be free from defects in material and workmanship for a period of one year from the purchase date. Any units or parts which prove defective during the warranty period will be replaced at the Manufacturers option when returned to Manufacturer.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Select and size products to achieve specified performance requirements.

B. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 GENERAL REQUIREMENTS FOR FLOW INSTRUMENTS

A. Air sensors and transmitters shall have an extended range of 20 percent above Project design flow and 20 percent below minimum Project flow to signal abnormal flow conditions and to provide flexibility for changes in operation.

2.3 ACCEPTABLE MANUFACTURERS

A. EBTRON, Inc. model GTx116-P+ is the basis of design

1. Basis of Design and Acceptable Manufacturers

a. Airflow measurement devices shall use the principle of thermal dispersion and provide one self-heated bead-in-glass thermistor and one zero power bead-in-glass thermistor at each sensing node.

   1) Thermal dispersion devices that indirectly heat a thermistor are not acceptable.

b. Substitution requests for acceptance less than 60 days prior to bid date or products submitted in non-conformance with the requirements of this specification will not be considered.

   1) For any product to be considered for substitution, a written document shall be submitted to the engineer detailing exceptions and compliance, section-by-section with supporting documentation, before an approval will be considered.

   2) Any product submitted as an equal shall be expected to comply with all performance capabilities and functional aspects of this specification.

c. Excluded devices:

   1) Fan Inlet airflow measurement devices.

   2) Measurement technologies using “chip-in-glass”, “chip-in-epoxy” or other “chip” type thermistors for the heated sensor component are not acceptable.

   3) Pitot tubes, Pitot arrays, Piezo rings and other differential pressure based devices are not acceptable.

   4) Vortex shedding devices are not acceptable.

2. Products approved

a. Approved performance equal
2.4 AIRFLOW MEASURING DEVICE

A. Airflow Measurement Devices (AMD) with Temperature Output and Airflow Alarming Capability

1. General
   a. Provide one AMD for each measurement location provided on the plans, schedules and/or control diagrams to determine the average airflow rate and temperature at each measurement location.
   b. Each AMD shall be provided with a microprocessor-based transmitter and one or more sensor probes.
      1) Devices that have electronic signal processing components on or in the sensor probe are not acceptable.
   c. Airflow measurement shall be field configurable to determine the average Actual or Standard mass airflow rate.
      1) Actual airflow rate calculations shall have the capability of being corrected by the transmitter for altitudes other than sea level.
   d. Temperature measurement shall be field configurable with velocity weighted average as the default or manual selection of arithmetic average temperature.

2. Sensor Probes
   a. Sensor probes shall be constructed of gold anodized, 6063 aluminum alloy tube, 316 stainless steel tube are available when required.
   b. Sensor probe mounting brackets shall be constructed of 304 stainless steel.
   c. Probe internal wiring between the connecting cable and sensor nodes shall be Kynar coated copper.
      1) PVC jacketed internal wiring is not acceptable.
   d. Probe internal wiring connections shall consist of solder joints and spot welds.
      1) Internal wiring connections shall be sealed and protected from the elements. They shall be capable of direct exposure to water without affecting instrument operation.
      2) Connectors of any type within the probe are not acceptable.
      3) Printed circuit boards within the probe are not acceptable.
   e. Each sensor probe shall be provided with an integral, FEP jacket, plenum rated CMP/CL2P, UL/cUL Listed cable rated for exposures from -67° F to 392° F (-55° C to 200° C) and continuous and direct UV exposure.
      1) Plenum rated PVC jacket cables are not acceptable.
   f. Each sensor probe cable shall be provided with a connector plug with gold plated pins for connection to the transmitter.
   g. Each sensor probe shall contain one or more independently wired sensing nodes.
h. Sensor node airflow and temperature calibration data shall be stored in a serial memory chip in the cable connecting plug and not require matching or adjustments to the transmitter in the field.

i. Each sensor node shall be provided with two bead-in-glass, hermetically sealed thermistors potted in a marine grade waterproof epoxy with sensor housings constructed of glass-filled polypropylene. Upon request, the manufacture shall provide a written independent laboratory test result of 100% survival rate in a 30 day saltwater and acid vapor test.

1) Devices that use epoxy or glass encapsulated chip thermistors are not acceptable.
2) Devices with exposed leads are not acceptable.

j. Each thermistor shall be individually calibrated at a minimum of 3 temperatures to NIST-traceable temperature standards.

k. Each sensor node shall be individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard and have an accuracy of ±2% of reading over the entire calibrated airflow range of 0 to 5,000 FPM (25.4 m/s).

1) Upon request the manufacture shall submit for AMD approval a copy of the NIST report of calibration used for the reference standard used.
   a) Devices claiming NIST traceability to third party laboratories and not directly to NIST are not acceptable
   b) Devices calibrated against standards other than the NIST LDA are not acceptable.

l. Accuracy shall include the combined uncertainty of the sensor nodes and transmitter.

m. The installed airflow accuracy shall be:

   1) Ducts - ±3% of reading when installed in accordance with the manufactures recommended placement guidelines.
   2) Non-ducted Outdoor Air intakes - better than or equal to ±5% of reading when installed in accordance with the manufactures recommended placement guidelines.

n. Devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter shall demonstrate compliance with this requirement over the entire operating range.

o. Each sensing node shall have a temperature accuracy of ±0.15° F (0.08° C) over an operating range of -20° F to 160° F. (-28.9° C to 71.1° C) and humidity range of 0 to 100% RH.

p. The number of independent sensor nodes provided shall be as follows:

<table>
<thead>
<tr>
<th>Area ft² [m²]</th>
<th># Sensor Nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 0.5 [≤ 0.046]</td>
<td>1</td>
</tr>
<tr>
<td>&gt; 0.5 &amp; ≤ 1 [≤ 0.092]</td>
<td>2</td>
</tr>
<tr>
<td>&gt; 1 &amp; ≤ 2 [&gt; 0.092 &amp; ≤ 0.185]</td>
<td>4</td>
</tr>
<tr>
<td>&gt; 2 &amp; ≤ 4 [&gt; 0.185 &amp; ≤ 0.371]</td>
<td>6</td>
</tr>
</tbody>
</table>
1) A total of 4 probes shall be required for openings with an aspect ratio ≤ 1.5 and with an area ≥ 25 ft² (≥ 2.32 m²).

3. Transmitter

a. A remotely located microprocessor-based transmitter shall be provided for each measurement location.

b. The transmitter shall be comprised of a main circuit board and interchangeable interface card.

c. All printed circuit board interconnects, edge fingers, receptacle plug pins and PCB test points shall be gold plated.

d. All printed circuit boards shall be electroless nickel immersion gold (ENIG) plated.

e. All integrated circuitry shall be temperature rated as ‘industrial-grade’. Submissions containing ‘commercial-grade’ integrated circuitry are not acceptable.

f. The transmitter shall be capable of determining the airflow rate and temperature average of all connected sensor nodes in an array for a single location.

1) Separate integration buffers shall be provided for display airflow output, airflow signal output (analog and network) and individual sensor output (Bluetooth).

g. The transmitter shall be capable of providing a high and/or low airflow alarm with user-defined set point and % of set point tolerance. Alarm shall be capable of being manually or automatically reset and low-limit cutoff value may be selected to disable the alarm. An alarm delay function shall also be field defined.

h. The transmitter shall be capable of identifying an AMD malfunction via the system status alarm and ignore any sensor node that is in a fault condition.

i. The transmitter shall be capable of field configuration, diagnostics and include Field Output Adjustment Wizard that allows for a one or two point field adjustment to factory calibration for installations that require adjustment.

j. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display.

k. The transmitter shall be provided one of the following output options:

1) Two field selectable (0-5/0-10 VDC or 4-20mA), scalable, isolated and overcurrent protected analog output signals (AO1=airflow, AO2=temperature or alarm) and one RS-485 BACnet/Modbus connection, or

2) Two field selectable (0-5/0-10 VDC or 4-20mA), scalable, isolated and overcurrent protected analog output signals (AO1=airflow, AO2=temperature or alarm) and one Ethernet BACnet/Modbus connection, or one isolated RS-485 (field selectable BACnet MS/TP or Modbus RTU) network connection, or

3) Two field selectable (0-5/0-10 VDC or 4-20mA), scalable, isolated and overcurrent protected analog output signals (AO1=airflow, AO2=temperature or alarm) and one proprietary wireless connection to EBTRON "Commissioner" based devices, or

4) One RS 485 BACnet/Modbus network connection and one Ethernet BACnet/Modbus or

5) One Lonworks Free Topology network connection, or

6) One thumb drive data logger (no output).
l. The analog signal capability shall include two output terminals: the first (AO1), shall provide the total airflow rate and the second output (AO2) shall be field configurable to provide one of the following:

1) temperature
2) low and/or high airflow user-defined set point alarm, or
3) system status alarm

m. The network communications RS-485 (BACnet MS/TP or Modbus RTU) or Ethernet (BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) shall provide: the average airflow rate, temperature, hi and/or low airflow set point alarm, system status alarm, individual sensor node airflow rates and individual sensor node temperatures. Individual node airflow rates and temperatures shall NOT be available via the network with Lon.

n. The transmitter shall be provided with a Bluetooth low energy interface card to interface with Android or iOS devices. Provide free Android or iOS software that allows real-time airflow and temperature monitoring and airflow and temperature traverses. Software shall capture, save or e-mail airflow and temperature data, transmitter settings and diagnostics information.

o. The transmitter shall have an on-off power switch. Isolation transformers shall not be required.

p. The transmitter shall be powered by 24 VAC (22.8 to 26.4 under load) @20 V-A maximum and use a switching power supply that is over-current and over-voltage protected.

q. The transmitter shall use a “watchdog” timer circuit to ensure automatic reset after power disruption, transients and brown-outs.

r. Each transmitter shall have an operating temperature range of -20° F to 120° F (-28.9° C to 48.9° C) and humidity range of 5 to 95% RH.

4. Listings and Certifications

a. The AMD shall be UL/cUL 873 Listed as an assembly.

1) Devices claiming compliance with the UL Listing based on individual UL component listing are not acceptable.

b. All network-capable AMD models supplied with RS-485 interface and BACnet protocol shall be BTL Listed.

c. The AMD shall be tested for compliance with the EMC Directive’s requirements and be certified to carry the CE Mark for European Union Shipments.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
D. Provide the services of an independent inspection agency to confirm that proposed mounting locations comply with requirements indicated and approved submittals.
   1. Indicate dimensioned locations with mounting height for all surface-mounted products to walls and ceilings on shop drawings.
   2. Do not begin installation without submittal approval of mounting location.

E. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.

F. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTRUMENT APPLICATIONS

A. Select from instrument types to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

B. Duct-Mounted Airflow Sensors:

C. Damper-Mounted Airflow Sensors:
   1. Measured Velocities 400 fpm and Less: Thermal airflow station.
   2. Measured Velocities Greater than 500 fpm, Pitot-tube airflow sensor station

D. Fan-Mounted Airflow Sensors:
   2. Measured Velocities Greater than 500 fpm: Pitot-tube fan inlet airflow sensor station

E. Airflow Switches:

F. Airflow Transmitters for Use with Pitot-Tube-Type Sensors:
   1. Exhaust Air Airflow: Airflow transmitter with 0.10 percent accuracy and auto-zero feature.
   2. Outdoor Air Airflow: Airflow transmitter with 0.10 percent accuracy and auto-zero feature.
   3. Return Air Airflow: Airflow transmitter with 0.25 percent accuracy and auto-zero feature.
   4. Supply Air Airflow: Airflow transmitter with 0.25 percent accuracy and auto-zero feature.

3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.
C. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to force.

D. Install ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 26 28 16 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

3.5 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

A. Mounting Location:

1. Rough-in: Outline instrument-mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
2. Install switches and transmitters for air and liquid flow associated with individual air-handling units and connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
3. Install liquid and steam flow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install airflow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
6. Install instruments in steam, liquid, and liquid-sealed-piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.
7. Install instruments in dry gas and non-condensable-vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.

B. Mounting Height:
1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Mount switches and transmitters, located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements, within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
   a. Make every effort to mount at 60 inches.

C. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

3.6 FLOW INSTRUMENTS INSTALLATION

A. Airflow Sensors:
   1. Install sensors in straight sections of duct with manufacturer-recommended straight duct upstream and downstream of sensor.
   2. Installed sensors shall be accessible for visual inspection and service. Install access door(s) in duct or equipment located upstream of sensor, to allow service personnel to hand clean sensors.

B. Transmitters:
   1. Install airflow transmitters serving an air system in a single location adjacent to or within system control panel.
   2. Install liquid flow transmitters, not integral to sensors, in vicinity of sensor. Where multiple flow transmitters serving same system are located in same room, co-locate transmitters by system to provide service personnel a single and convenient location for inspection and service.

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification and on face of ceiling directly below instruments concealed above ceilings.

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.
B. Wash and shine glazing.
C. Polish glossy surfaces to a clean shine.
3.9 CHECKOUT PROCEDURES

A. Description:

1. Check out installed products before continuity tests, leak tests, and calibration.
2. Check instruments for proper location and accessibility.
3. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

B. Flow Instrument Checkout:

1. Verify that sensors are installed correctly with respect to flow direction.
2. Verify that sensor attachment is properly secured and sealed.
3. Verify that processing tubing attachment is secure and isolation valves have been provided.
4. Inspect instrument tag against approved submittal.
5. Verify that recommended upstream and downstream distances have been maintained.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer's recommendations.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after-calibration-indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
C. Digital Signals:
   1. Check digital signals using a jumper wire.
   2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:
   1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
   2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

END OF SECTION 23 09 25
SECTION 23 09 26 - CONTROL DAMPERS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes control dampers and actuators.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS
   A. Operation and maintenance data.

1.4 WARRANTY
   A. Warranty: Manufacturer agrees to repair or replace components of dampers and actuators that fail in materials or workmanship within a 2 year warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   B. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

2.2 GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS
   A. Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.
   B. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the fan shutoff pressure as a minimum requirement.
   C. The total damper area operated by an actuator shall not exceed 80 percent of manufacturer's maximum area rating.
D. Provide one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.

E. Avoid the use of excessively oversized actuators which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.

F. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.

G. Provide mounting hardware and linkages for connecting actuator to damper.

H. Select actuators to fail in desired position in the event of a power failure.

I. Actuator Fail Positions as indicated below:
   1. Exhaust Air: Open.
   2. Outdoor Air: Open.

2.3 ELECTRIC AND ELECTRONIC ACTUATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belimo.
   2. Honeywell.

B. Type: Motor operated, with or without gears, electric and electronic.

C. Voltage:
   1. 24 V for modulating.
   2. 120V for two position.
   3. Modulating or two position as called for in section 23 09 93 "Sequence of Operations for HVAC".
   4. Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
   5. Actuator shall function properly within a range of 85 to 120 percent of nameplate voltage.

D. Construction:
   1. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
   2. 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.

E. Field Adjustment:
   1. Spring return actuators shall be easily switchable from fail open to fail closed in the field without replacement.
   2. Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.
F. Two-Position Actuators: Single direction, spring return or reversing type.

G. Modulating Actuators:

1. Capable of stopping at all points across full range, and starting in either direction from any point in range.
2. Control Input Signal:
   a. Programmable Multi-Function:
      1) Control input, position feedback, and running time shall be factory or field programmable.

H. Position Feedback:

1. Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
2. Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
3. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

I. Fail-Safe:

1. Where indicated, provide actuator to fail to an end position.
2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

J. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

K. Damper Attachment:

1. Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
2. Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

L. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, non-condensing.

M. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. Provide actuator enclosure with a heater and controller where required by application.

N. Stroke Time:
1. Operate damper from fully closed to fully open within 15 seconds.
2. Operate damper from fully open to fully closed within 15 seconds.
3. Move damper to failed position within 15 seconds.
4. Select operating speed to be compatible with equipment and system operation.
5. Actuators operating in smoke control systems comply with governing code and NFPA requirements.

O. Sound:
1. Spring Return: 62 dBA.
2. Non-Spring Return: 45 dBA.

2.4 RECTANGULAR CONTROL DAMPERS

A. General Requirements:
1. Unless otherwise indicated, use opposed blade configuration for two-position and modulating control.
2. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application. Sections to be screwed together at the factory, not welded, to allow for ease of installation in field.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck.
2. Ruskin.
3. Carnes.

C. Rectangular Dampers with 3-V Steel Blades:
1. Performance:
   a. Leakage: AMCA 511, Class 1. Leakage shall not exceed 3 cfm/sq. ft. against 1-in. wg differential static pressure.
   b. Pressure Drop: 0.04-in. wg at 1500 fpm across a 24-by-24-inch damper when tested according to AMCA 500-D, figure 5.3.
   c. Velocity: Up to 3000 fpm.
   d. Temperature: Minus 40 to plus 185 deg F.
   e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.
   f. Damper shall have AMCA seal for both air leakage and air performance.
2. Construction:
   a. Frame:
2) Hat-shaped channel with integral flanges. Mating face shall be a minimum of 1 inch.
3) Width not less than 5 inches.

b. Blades:
1) 3V, 16 ga galvanized steel in non-corrosive environments.
2) 3V, 316 stainless steel in corrosive environments (Screen Rooms).
3) Opposed blade configuration as required by application.
4) Material: ASTM A653/A653M galvanized steel, 0.05 inch thick or 316 stainless steel.
5) Width not to exceed 6 inches.
6) Length as required by close-off pressure, not to exceed 48 inches.

c. Seals:
1) Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.
2) Jambs: Stainless steel, compression type.

d. Axles: 0.5-inch-diameter plated steel for non-corrosive environments and 316 stainless steel for corrosive environments (Screen Rooms), mechanically attached to blades.

e. Bearings:
1) Synthetic (acetal) sleeve rotating in polished extruded holes in the damper frame for non-corrosive environments.
2) 316 Stainless steel sleeve rotating in polished extruded holes in the damper frame.

f. Linkage:
1) Concealed in frame.
2) Constructed of plated steel for non-corrosive environments and stainless steel for corrosive environments (Screen Rooms).
3) Hardware: Stainless steel.

g. Transition:
1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.
2) Factory mount damper in a sleeve with a close transition to mate to field connection.
3) Damper size and sleeve shall be connection size plus 2 inches.
4) Sleeve length shall be not less than 12 inches for dampers without jackshafts and shall be not less than 16 inches for dampers with jackshafts.
5) Sleeve material shall match adjacent duct.

h. Additional Corrosion Protection for Corrosive Environments:
1) Provide epoxy finish for surfaces in contact with airstream.
2) Axles, damper linkage, and hardware shall be constructed of Type 316 stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install dampers in accordance with manufacturer’s UL Installation Instructions. Any damper installation aspect that is not in accordance with the manufacturer’s UL Installation Instructions must be approved prior to installation.

B. Furnish and install products required to satisfy most stringent requirements indicated.

C. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment.

D. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. The installing contractor shall provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.

F. Do not compress or stretch the damper frame into the duct or opening.

G. Attach multiple damper section assemblies together in accordance with manufacturer’s instructions. Install support mullions for reinforcement between assemblies as required.

H. Seal penetrations made in fire-rated and acoustically rated assemblies.

I. Fastening Hardware:
   1. Stillson wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
   2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
   3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

J. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

K. Corrosive Environments:
   1. Use products that are rated Class I, Division I, suitable for environment to which they will be subjected.
   2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:
      a. Screen Rooms.
3. Use Type 316 stainless-steel tubing and fittings when in contact with a corrosive environment.
4. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
5. Where actuators are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.2 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.
B. Furnish and install power wiring. Comply with requirements in Section 26 05 19 “Low Voltage Electrical Power Conductors and Cables”.
C. Furnish and install raceways. Comply with requirements in Section 26 05 33 “Raceways and Boxes for Electrical Systems”.

3.3 CONTROL DAMPERS & ACTUATORS

A. Clearance:
   1. Locate actuators for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
   2. Install actuators with at least 24 inches of clear space on sides of dampers requiring service access.
B. Service Access:
   1. Actuators shall be accessible for visual inspection and service.
   2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 23 33 00 AIR DUCT ACCESSORIES.
C. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
D. Attach actuator(s) to damper drive shaft.
E. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.
F. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 26 05 26 “Grounding and Bonding for Electrical Systems”.
G. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 “Identification for Electrical Systems.”
H. Install engraved phenolic nameplate with damper identification on damper and on face of duct where damper is concealed.
3.4 CHECKOUT PROCEDURES

A. Control-Damper Checkout:
   1. Check installed products before continuity tests, leak tests, and calibration.
   2. Check dampers for proper location and accessibility.
   3. Verify that control dampers are installed correctly for flow direction.
   4. Verify that proper blade alignment, either parallel or opposed, has been provided.
   5. Verify that damper frame attachment is properly secured and sealed.
   6. Verify that damper actuator and linkage attachment are secure.
   7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
   8. Verify that damper blade travel is unobstructed.

3.5 ADJUSTMENT, CALIBRATION, AND TESTING:

A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

C. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 23 09 26
SECTION 23 09 27 - GAS INSTRUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes the Following Gas Instruments:
   1. Eight Channel Gas Detection Controller.
B. Related Requirements:
   1. Section 23 10 10 “Monitoring and Control System for HVAC” for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
   2. Section 23 09 93 “Sequence of Operations for HVAC”.

1.3 DEFINITIONS
A. NDIR: Nondispersive infrared.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product, including the following:
   1. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
   2. Installation instructions, including factor affecting performance.
B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting details.
   2. Include diagrams for power, signal, and control wiring.
   3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.
1.5 INFORMATIONAL SUBMITTALS
   A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For gas instruments to include in operation and maintenance manuals.

1.7 WARRANTY
   A. Warranty: Manufacturer agrees to repair or replace instruments that fail in materials or workmanship within a 2 year warranty period.

PART 2 - PRODUCTS

2.1 EIGHT CHANNEL GAS DETECTION CONTROLLER
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. RKI Instruments
   B. Description:
      1. Eight Channel Wall Mounted Controller with three alarm levels per channel.
   C. Construction:
      1. House electronics in an ABS plastic enclosure. Provide equivalent of NEMA 250, Type 4X enclosure for wall-mounted space applications.
      2. Equip with digital display for continuous indication of gas concentration.
   D. Enclosure:
      1. Class I Division I Rated NEMA 250, Type 4X.
      2. Access to the inside of enclosure, as well as to controller, display, and wiring connections, shall be through full-length door on front of enclosure.
      3. Door with shatterproof window sized to provide viewing of visual display and indicator lights.
      4. Equip enclosure with mounting brackets for the purpose of attaching the unit to a flat surface.
      5. Provide door with key lock access to inside enclosure.
   E. Visual Display:
      1. Four-digit LED or backlight LCD display visible from front face of enclosure.
      2. Value displayed shall be a direct reading of gas concentration.
      3. Displays system status indicators.
      4. Visual Alarm Indication:
a. Three separate alarm levels: Alert, Warning and Alarm.

5. Indication of sensor nearing end of its useful life based on the sensor output, not on the time the sensor was in service.
6. Displays average, minimum, and maximum gas concentrations of the sensor over selected time.
7. Malfunction Indication Alarm: Displays a separate unique character when an over range or under range condition exists, a sensor signal sensor is lost, or a set-point error or memory failure occurs.

F. Visible Alarm:

1. Provide a visible and audible signal when an alarm condition occurs as shown on project drawings.
2. Alarm shall be include Blue Strobe, Red Strobe, and Horn selectable output signals.
3. Mount lights inside and on exterior of building as shown on project drawings.

G. Operator Interface:

1. Operating Modes and Parameters Selection: Selections listed shall be accomplished by the use of switches, jumpers, or remote control not involving the use of tools.
   a. Display range value.
   b. Latching or nonlatching mode for the alarm set points.
   c. Upscale or downscale acting alarms.

H. Output Signal:

1. Relays:
   a. Provide one relay for each set-point level for each of the three alarm levels.
   b. Provide one relay for each fault condition.
   c. Provide one relay for each visible alarm.
   d. Alarm and fault relays shall be form "C," SPDT. Contacts shall be rated for 5 A resistive at 250-V ac or 30-V dc.
   e. Contacts shall be capable of being selected normally open or normally closed.
   f. Alarm relays shall be normally de-energized. The fault relay shall be normally energized.
   g. Provide contacts and relays to SCADA. See Specification 23 09 93 "Sequence of Operations for HVAC*.

2. Digital Communication:
   a. Bidirectional sending and receiving of digital signals.
   b. Digital signals shall comply with FTT-10-based communication.
   c. Protocol shall be BACNet.
   d. Signal speed shall be no greater than 78.1 kBs per second.

I. Options:

1. Factory installed recorder output board, 8 outputs.
2. Manufacturer startup and maintenance service for 24 months
3. Calibration kit.
4. Polyurethane tubing for remote methane sensor mounting.
2.2 HYDROGEN-SULFIDE/METHANE/LEL/CARBON MONOXIDE TRANSMITTERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. RKI Instruments

B. Description:
   1. System shall measure and display a single gas concentration, provide local audio and visual alarms when preset limits are exceeded, and send output signals of gas concentration and detected alarms.
   2. System shall require no periodic maintenance other than periodic checking of sensor response to a known concentration of gas.
   3. System shall be designed to provide for installation, setup, and start-up from outside of unit enclosure without need to open the enclosure door.
   4. System shall be factory calibrated and ready for operation after installation.
   5. Monitor shall be internally wired to accommodate a single-point field power connection.

C. Performance:
   1. Range: Full scale, zero to 10,000 ppm.
   2. Zero Drift: Within 1 percent per year.
   3. Span Drift: Within 10 percent per year.
   4. Repeatability: Within 1 percent of full scale.
   5. Linearity: Within 2 percent of full scale.

D. Sensor:
   1. Electrochemical fuel-cell type does not require periodic addition of reagents.
   2. Sensor shall be replaceable without the need for tools.
   3. Sensors shall have a minimum useful life of one year. Replace failed sensors at no charge as necessary within the first 2 years of operation.
   4. Mount sensor externally on the side or bottom of enclosure. Where indicated on Drawings, mount sensor remote from enclosure.
   5. Remote Mounting:
      a. Provide sensor in a separate enclosure. Enclosure shall be NEMA 250, Type 4X, except when sensor is installed in a hazardous location, then enclosure shall be an explosion-proof type suitable for the application.
      b. Provide sensor with cable for connecting to monitor.
      c. Provide sensor with mounting hardware suitable for application.

E. Gas Sampling Pump:
   1. Where required by application, provide a pump mounted inside the enclosure to provide a motive force to induce flow of gas sample across the sensor.
   2. Signal to the sensor from the pump shall be in digital communication format to eliminate radio-frequency interference (RFI) and electromagnetic interference (EMI).
   3. A flow sensor shall activate a relay when the gas sample falls below the acceptable flow rate to the sensor and shall indicate a loss of gas flow on the display.
   4. Introduction of a calibration gas to the gas sensor shall be through an integral push-button valve. This push-button valve shall return to monitoring the sampled area when released.
F. Calibration:

1. Calibrate and adjust functions through nonintrusive hand-held wireless remote control without opening enclosure door.
2. Enter calibration mode through hand-held wireless remote control unit. The display of the monitor shall instruct the user on when to apply zero and span gas. The system shall automatically adjust its internal settings to the proper calibration values without further intervention by the user. On completion of a successful calibration, the system shall exit the calibration mode. Date stamp of last successful calibration is retained in the system internal memory, with capability to be indicated on display. If calibration is unsuccessful for any reason, the display shall show an unsuccessful calibration attempt and revert to its previous calibration settings.
3. Wireless method shall employ a digitally encoded infrared light beam.
4. The monitor infrared link shall not be affected by natural and man-made low-level ambient light.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy more stringent of all requirements indicated.
B. Install products level, plumb, parallel, and perpendicular with building construction.
C. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to seismic loads.
D. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by using excessive force or oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

F. Corrosive Environments:
   1. Use products that are suitable for environment to which they are subjected.
   2. If possible, avoid or limit use of materials in corrosive environments, including but not limited to, the following:
      a. Screen Rooms.
   3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
   4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.3 ELECTRICAL POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 26 28 16 “Enclosed Switches for Circuit Breakers”.

C. Furnish and install power wiring. Comply with requirements in Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables”.

D. Furnish and install raceways. Comply with requirements in Section 26 05 33 “Raceways and Boxes for Electrical Systems”.

3.4 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

A. Mounting Location:
   1. Install transmitters for gas associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
   2. Install gas switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
   3. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer’s mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
   4. Install instruments in dry gas and non-condensable vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.

B. Mounting Height:
1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
   a. Make every effort to mount at 60 inches.

C. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated, using neoprene gaskets or grommets.

3.5 HYDROGEN SULFIDE MONITORING SYSTEM
A. Install monitor in space to provide an accurate measurement of gas concentration.
B. Support hydrogen sulfide monitoring system from wall, at manufacturer recommended height.
C. Alarm Levels:
   1. 0 to 20 ppm – Low Level Alarm
   2. 21 to 99 ppm – Mid Level Alarm (Make-Up Air & Exhaust to 100%)
   3. 100 ppm or Above – High Alarm (Notify SCADA System)

3.6 METHANE MONITORING SYSTEM
A. Install monitor in space to provide an accurate measurement of gas concentration.
B. Support methane monitoring system from wall, at manufacturer recommended height.
C. Alarm Levels:
   1. 0 to 50% LEL – Low Level Alarm
   2. 51 to 99% LEL – Mid Level Alarm (Make-Up Air & Exhaust to 100%)
   3. 100% LEL OR Above – High Alarm (Notify SCADA System)

3.7 CARBON MONOXIDE MONITORING SYSTEM
A. Install monitor in space to provide an accurate measurement of gas concentration.
B. Support methane monitoring system from wall, at manufacturer recommend height.
C. Alarm Levels:
   1. 0 to 200 ppm – Low Level Alarm
   2. 201 to 400 ppm – Mid Level Alarm (Make-Up Air & Exhaust to 100%)
   3. 401 ppm OR Above – High Alarm (Notify SCADA System)

3.8 IDENTIFICATION
A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at
points of connection. Comply with requirements for identification specified in Section 26 05 53 “Identification for Electrical Systems”.

B. Install engraved phenolic nameplate with instrument identification on face.

3.9 CHECKOUT PROCEDURES

A. Check out installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.

D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
4. Equipment and procedures used for calibration shall comply with instrument manufacturer's written recommendations.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have an accuracy of at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures in ASHRAE Guideline 11, “Field Testing of HVAC Control Components,” in the absence of specific requirements, and to supplement requirements indicated.

B. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

C. Meters: Check sensors at zero, 50, and 100 percent of Project design values.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:
1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

G. Occupancy Adjustments: Within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.11 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 24 months' full maintenance by skilled employees of gas system and equipment Installer or manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, calibration, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.12 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform according to manufacturer's written instruction.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.13 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

END OF SECTION 23 09 27
Not to be used for bidding purposes
SECTION 23 09 30 - PRESSURE INSTRUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Air-pressure sensors.
   2. Air-pressure switches.
   3. Air-pressure transmitters.
   4. Liquid-pressure switches.
   5. Liquid-pressure transmitters.

B. Related Requirements:
   1. Section 23 10 10 “Monitoring and Control System for HVAC” for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
   2. Section 23 09 93 “Sequence of Operations for HVAC”.

1.3 DEFINITIONS

A. HART: Highway addressable remote transducer protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bi-directional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from technician's hand-held device or laptop to a control, asset management, safety, or other system using any control platform.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:
   1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
4. Installation instructions, including factors affecting performance.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Product installation location shown in relationship to room, duct, pipe, and equipment.
2. Wall-mounted instruments located in finished space, showing relationship to light switches, fire alarm devices, and other installed devices.
3. Size and location of wall access panels for instruments installed behind walls.
4. Size and location of ceiling access panels for instruments installed in accessible ceilings.

B. Product Certificates: For each product requiring a certificate.

C. Product Test Reports: For each product requiring test performed by a qualified testing agency.

D. Source quality-control reports.

E. Field quality-control reports.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Provide one matching product(s) in Project inventory for each unique size and type of sensor.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

1.8 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace instruments that fail in materials or workmanship within a 2 year warranty period.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
   
   a. If instrument alone cannot comply with requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance.

2. Instruments and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Instrument-installed location shall dictate following NEMA 250 enclosure requirements:
   
   a. Outdoors, Protected: Type 12.
   b. Outdoors, Unprotected: Type 4X.
   c. Indoors, Heated with Filtered Ventilation: Type 1
   d. Indoors, Heated with Nonfiltered Ventilation: Type 12.
   e. Mechanical Equipment Rooms:
      
      1) Boiler Rooms: Type 12.
      2) Air-Moving Equipment Rooms: Type 12.
   f. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 3.
   g. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
   h. Hazardous Locations: Explosion-proof rating for condition.

2.2 AIR-PRESSURE SENSORS

A. Duct Insertion Static Pressure Sensor:

1. Sensor probe with two opposing orifices designed to reduce error-associated air velocity.
2. Sensor insertion length shall be at least 4 inches.
3. Construct sensor of Type 304 stainless steel.
4. Connection: Threaded, NPS 1/8 swivel fitting for connection to copper tubing or NPS 1/4 barbed fitting for connection to polyethylene tubing.
5. Sensor probe attached to a mounting flange with neoprene gasket and two holes for fasteners.
6. Mounting flange shall suitable for flat oval, rectangular, and round duct configurations.
7. Pressure Rating: 10 psig.

B. Outdoor Static Pressure Sensor:

1. Sensor with no moving parts.
2. Operation not affected and impaired by rain and snow.
3. Sensing plates constructed of 0.1406-inch Type 316 stainless steel.
4. Accuracy within:
   a. 1 percent of the actual outdoor atmospheric pressure when subjected to varying horizontal radial wind velocities up to 40 mph.
   b. 2 percent of the actual outdoor atmospheric pressure while subjected to varying radial wind velocities up to 40 mph with approach angles up to 30 degrees to horizontal.
   c. 3 percent of the actual outdoor atmospheric pressure while subjected to varying radial wind velocities up to 40 mph with approach angles up to 60 degrees to horizontal.

C. Space Static Pressure Sensor for Wall Mounting:
   1. Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm from a 360-degree radial source.
   2. Stainless steel with perforations arranged to sense space static pressure. Exposed surfaces provided with brush finish.
      a. Sensor fitted with multiple sensing ports, pressure impulse suppression chamber, and airflow shielding.
   3. 100-micron filter mounted in stainless-steel wall plate senses static pressure.
   4. Wall plate provided with gasket and screws, and sized to fit standard single-gang electrical box.
   5. Back of sensor plate fitted with brass barbed fitting for tubing connection.

2.3 AIR-PRESSURE SWITCHES

A. Air-Pressure Differential Switch:
   1. Diaphragm operated to actuate an SPDT snap switch.
   2. Electrical Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.
   3. Enclosure Conduit Connection: Knock out or threaded connection.
   4. User Interface: Screw-type set-point adjustment located inside removable enclosure cover.
   6. Enclosure:
      a. Dry Indoor Installations: NEMA 250, Type 1.
      b. Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
      c. Hazardous Environments: Explosion proof.
   7. Operating Data:
      a. Electrical Rating: 15 A at 120- to 480-V ac.
      b. Pressure Limits:
         1) Continuous: 45 inches wg.
         2) Surge: 10 psig.
c. Temperature Limits: Minus 30 to 180 deg F.
d. Operating Range: Approximately 2 times set point.
e. Repeatability: Within 3 percent.
f. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 AIR-PRESSURE TRANSMITTERS

A. Air-Pressure Differential Transmitters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Ashcroft.

2. Performance:

   a. Range: Approximately 2 times set point.
   b. Accuracy: Within 0.5 percent of the span at reference temperature of 70 degrees F.
   c. Hysteresis: Within 0.02 percent of the span.
   d. Repeatability: Within 0.05 percent of the calibrated span.
   e. Stability: Within 0.25 percent of span per year.
   g. Temperature Limits: Minus 20 to 185 deg F.
   h. Compensate Temperature Limits: Zero to 160 deg F.
   i. Thermal Effects: 0.01 percent of full scale per degree F.
   j. Warm-up Time: Within 5 seconds.
   k. Response Time: 8 ms.
   l. Shock and vibration shall not harm the transmitter.

3. Output Signals:

   a. Analog Current Signal:
      1) Two-wire, 4- to 20-mA dc current source.
      2) Signal capable of operating into 1000-ohm load.

   b. Analog Voltage Signal:
      1) Three wire, zero to 6 V.
      2) Minimum Load Resistance: 1000 ohms.

4. Operator Interface:

   a. Zero and span adjustments within 10 percent of full span.
   b. Potentiometer adjustments located on face of transmitter.

5. Construction:

   a. Type 300 stainless-steel enclosure.
   b. Swivel fittings for connection to tubing. Fittings on bottom of instrument enclosure.
   c. Two 1/2-inch trade size conduit connections isolated from electronics.
d. Screw terminal block for wire connections.
e. Vertical plane mounting.
f. NEMA 250, Type 2.
g. Mounting Bracket: Appropriate for installation.

6. Reverse wiring protected.
7. Calibrate to NIST-traceable standards and provide each transmitter with a certificate of calibration.

B. Air-Pressure Differential Indicating Transmitter:

1. Performance:
   a. Range: Approximately 2 times set point.
   b. Accuracy Including Hysteresis and Repeatability: Within 1 percent of full scale at 77 deg F.
   c. Stability: Within 1 percent of full scale per year.
   d. Overpressure: 10 psig.
   e. Temperature Limits: 20 to 120 deg F.
   f. Thermal Effects: 0.055 percent of full scale per degree F.

2. Display: Four-digit digital display with minimum 0.4-inch-high numeric characters.
3. Operator Interface:
   a. Zero and span adjustments.
   b. Selectable engineering units.
4. Analog Output Current Signal:
   a. Two-wire, 4- to 20-mA dc current source.
   b. Signal capable of operating into a 1200-ohm load.
5. Construction:
   a. Plastic casing with clear plastic cover.
   b. Integral fittings for plastic tubing connections on side of instrument case for high- and low-pressure connections.
   c. Terminal block for wire connections.
   d. Vertical plane mounting.
   e. NEMA 250, Type 1.
   f. Nominal 4-inch diameter face.
   g. Mounting Bracket: Appropriate for installation.

2.5 LIQUID-PRESSURE SWITCHES

A. Liquid Gage Pressure Switch, Diaphragm Operated, Low Pressure:

1. Description:
   a. Diaphragm operated to actuate an SPDT snap switch.
   b. Electrical Connections: Screw terminal.
   c. Enclosure Conduit Connection: Knock out or threaded connection.
   d. User Interface: External screw with visual set-point adjustment.
f. Enclosure:
   1) Dry Indoor Installations: NEMA 250, Type 1.
   2) Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
   3) Hazardous Environments: Explosion proof.

2. Operating Data:
   a. Electrical Rating: 15 A at 120-V ac.
   b. Pressure Limits:
      1) Range 1 to 30 psig: 60 psig.
      2) Range 10 to 125 psig: 160 psig.
   c. Temperature Limits: Minus 30 to 150 deg F.
   d. Operating Range: 1 to 30 psig.
   e. Deadband: Adjustable or fixed as required by application.

3. Pressure Chamber Material: Steel.

B. Liquid-Pressure Differential Switch with Set-Point Indicator:

1. Description:
   a. Brass double opposing bellows operate to actuate a SPDT snap switch.
   b. Electrical Connections: Screw terminal.
   c. Enclosure Conduit Connection: Knock out or threaded connection.
   d. User Interface: Thumbscrew set-point adjustment with enclosed set-point indicator and scale.
   f. Enclosure:
      1) Dry Indoor Installations: NEMA 250, Type 1.
      2) Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
      3) Hazardous Environments: Explosion proof.

g. Operating Data:
   1) Electrical Rating: 15 A at 120- to 240-V ac.
   2) Pressure Limits: At least 5 times full-scale range, but not less than system design pressure rating.
   3) Temperature Limits: Minus 10 to 180 deg F.
   4) Operating Range: Approximately 2 times set point.
   5) Deadband: Adjustable or fixed as required by application.

2.6 LIQUID-PRESSURE TRANSMITTERS

A. Liquid-Pressure Differential Transmitter:

1. Performance:
   a. Range: Approximately 2 times set point.
   b. Span: Adjustable plus or minus one milliamp, noninteractive.
c. Accuracy: Within 0.25 percent of full scale.
d. Pressure: Maximum operating pressure 2.5 times range.
e. Temperature Limits: Zero to 175 deg F.
f. Compensate Temperature Limits: 30 to 150 deg F.
g. Thermal Effects: 0.02 percent of full scale per degree F.
h. Response Time: 30 to 50 ms.
i. Shock and vibration shall not harm the transmitter.

2. Analog Output Current Signal:
   a. Two-wire, 4- to 20-mA dc current source.
   b. Signal capable of operating into 1000-ohm load.

3. Operator Interface:
   a. Zero and span adjustments located behind cover.
   b. Bleed screws on side of body, two screws on low-pressure side, and one screw on high-pressure side, for air in line and pressure cavity.

4. Construction:
   a. Aluminum and stainless-steel enclosure with removable cover.
   b. Wetted parts of transmitter constructed of 17-4 PH or 300 Series stainless steel.
   c. Threaded, NPS 1/4 process connections on side of instrument enclosure.
   d. Knock out for 1/2-inch nominal conduit connection on side of instrument enclosure.
   e. Screw terminal block for wire connections.
   f. NEMA 250, Type 4X.
   g. Mounting Bracket: Appropriate for installation.

5. Three-valve manifold. Construct manifold of brass, bronze, or stainless steel. Manifold shall have threaded, NPS 1/4 process connections.

2.7 SOURCE QUALITY CONTROL
A. Factory Tests: Test and inspect assembled pressure instruments as indicated by instrument requirements. Affix standards organization's certification and label.
B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL
A. Install products level, plumb, parallel, and perpendicular with building construction.
B. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment.
C. Provide ceiling, floor, roof, wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
D. Fastening Hardware:
   1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
   2. Tighten bolts and nuts firmly and uniformly. Do not to overstress threads by using excessive force or oversized wrenches.
   3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner’s access, confirm unrestricted ladder placement is possible under occupied condition.
F. Corrosive Environments:
   1. Use products that are suitable for environment to which they are subjected.
   2. If possible, avoid or limit use of materials in corrosive environments.
   3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
   4. Where instruments are located in a corrosive environment and are not corrosive resistant from the manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.3 ELECTRICAL POWER
A. Furnish and install electrical power to products requiring electrical connections.
B. Furnish and install circuit breakers. Comply with requirements in Section 26 28 16 “Enclosed Switches and Circuit Breakers”.
C. Furnish and install power wiring. Comply with requirements in Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables”.
D. Furnish and install raceways. Comply with requirements in Section 26 05 33 “Raceways and Boxes for Electrical Systems”.
3.4 PRESSURE INSTRUMENT INSTALLATION

A. Mounting Location:
1. Rough-in: Outline instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.
2. Install switches and transmitters for air and liquid pressure associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
3. Install liquid and steam pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install air-pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

C. Duct Pressure Sensors:
1. Install sensors using manufacturer's recommended upstream and downstream distances.
2. Unless indicated on Drawings, locate sensors approximately 50 percent of distance of longest hydraulic run. Location of sensors shall be submitted and approved before installation.
3. Install mounting hardware and gaskets to make sensor installation airtight.
4. Route tubing from the sensor to transmitter.
5. Use compression fittings at terminations.
6. Install sensor in accordance with manufacturer's instructions.
7. Support sensor to withstand maximum air velocity, turbulence, and vibration encountered to prevent instrument failure.

D. Outdoor Pressure Sensors:
1. Install roof-mounted sensor in least-noticeable location and as far away from exterior walls as possible.
2. Locate wall-mounted sensor in an inconspicuous location.
3. Submit sensor location for approval before installation.
4. Verify signal from sensor is stable and consistent to all connected transmitters. Modify installation to achieve proper signal.
5. Route outdoor signal pipe full size of sensor connection to transmitters. Install branch connection of size required to match to transmitter.
6. Install sensor signal pipe with dirt leg and drain valve below roof penetration.
7. Insulate signal pipe with flexible elastomeric insulation as required to prevent condensation.
8. Connect roof-mounted signal pipe exposed to outdoors to building grounding system.

E. Air-Pressure Differential Switches:

Not to be used for bidding purposes.
1. Install air-pressure sensor in system for each switch connection. Install sensor in an accessible location for inspection and replacement.
2. A single sensor may be used to share a common signal to multiple pressure instruments.
3. Install access door in duct and equipment to access sensors that cannot be inspected and replaced from outside.
4. Route NPS 3/8 tubing from sensor to switch connection.
5. Do not mount switches on rotating equipment.
6. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
7. Install switches in an easily accessible location serviceable from floor.
8. Install switches adjacent to system control panel if within 50 feet; otherwise, locate switch in vicinity of system connection.

F. Liquid-Pressure Differential Switches:

1. Where process connections are located in mechanical equipment room, install switch in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate switch near system control panel.
3. Where multiple switches serving same system are installed in same room, install switches by system to provide service personnel a single and convenient location for inspection and service.
4. System process tubing connection shall be full size of switch connection, but not less than NPS 1/2. Install bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to switch.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each switch connection.
8. Do not mount switches on rotating equipment.
9. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
10. Install switches in an easily accessible location serviceable from floor.

G. Liquid-Pressure Transmitters:

1. Where process connections are installed in mechanical equipment room, install transmitter in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate transmitter near system control panel.
3. Where multiple transmitters serving same system are installed in same room, install transmitters by system to provide service personnel a single and convenient location for inspection and service.
4. System process tubing connection shall be full size of switch connection, but not less than NPS 1/2. Install bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to transmitter.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each transmitter connection.
8. Do not mount transmitters on equipment.
9. Install in a location free from vibration, heat, moisture, or adverse effects, which could damage and hinder accurate operation.
10. Not to be used for bidding purposes.
3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 26 05 53 “Identification for Electrical Systems”.

B. Install engraved phenolic nameplate with instrument identification.

3.6 CHECKOUT PROCEDURES

A. Check out installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.

3.7 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
4. Equipment and procedures used for calibration shall comply with instrument manufacturer's recommendations.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, “Field Testing of HVAC Control Components,” in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:
   1. Check and calibrate transmitters at zero, 50, and 100 percent of project design values.

G. Occupancy Adjustments: Within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Perform according to manufacturer's written instruction.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

END OF SECTION 23 09 30
Not to be used for bidding purposes
SECTION 23 09 31 - TEMPERATURE INSTRUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Air temperature sensors.
   2. Air Temperature Switches.
   3. Air temperature RTD transmitters.
   5. Commercial-grade, liquid and steam temperature transmitters.

B. Related Requirements:
   1. Section 23 10 10 “Monitoring and Control System for HVAC” for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
   2. Section 23 09 93 “Sequence of Operations for HVAC”.

1.3 DEFINITIONS

A. HART (Highway Addressable Remote Transducer) Protocol: The global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bidirectional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from a technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.

B. RTD: Resistance temperature detector.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:
   1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
4. Installation operation and maintenance instructions, including factors affecting performance.

B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.
   4. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.5 INFORMATIONAL SUBMITTALS
   A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
      1. Product installation location shown in relationship to room, duct, pipe, and equipment.
      2. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
      3. Sizes and locations of wall access panels for instruments installed behind walls.
      4. Sizes and locations of ceiling access panels for instruments installed in inaccessible ceilings.
   B. Product Certificates: For each product requiring a certificate.
   C. Product Test Reports: For each product, for tests performed by a qualified testing agency.
   D. Field quality-control reports.

1.6 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   B. Provide one matching product(s) in Project inventory for each unique size and type of sensor.

1.7 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

1.8 WARRANTY
   A. Warranty: Manufacturer agrees to repair or replace instruments that fail in materials or workmanship within a 2 year warranty period.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
   a. If instrument alone cannot meet requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance.

2. Instruments and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Instrument's installed location shall dictate following NEMA 250 enclosure requirements:
   a. Outdoors, Protected: Type 12.
   b. Outdoors, Unprotected: Type 4X.
   c. Indoors, Heated with Filtered Ventilation: Type 1.
   d. Indoors, Heated with Non-Filtered Ventilation: Type 12.
   e. Mechanical Equipment Rooms:
      1) Boiler Rooms: Type 12.
      2) Air-Moving Equipment Rooms: Type 12.
   f. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 12.
   g. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
   h. Hazardous Locations: Explosion-proof rating for condition.

2.2 AIR TEMPERATURE SENSORS

A. Platinum RTDs: Common Requirements:

1. 100 or 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
3. Performance Characteristics:
   a. Range: Minus 50 to 275 deg F.
   b. Interchangeable Accuracy: At 32 deg F within 0.5 deg F.
   c. Repeatability: Within 0.5 deg F.
4. Transmitter Requirements:
   a. Transmitter required for each 100-ohm RTD.
   b. Transmitter optional for 1000-ohm RTD, contingent on compliance with end-to-end control accuracy.
B. Platinum RTD, Single-Point Air Temperature Duct Sensors:

1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 275 deg F
4. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches.
5. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
6. Gasket for attachment to duct or equipment to seal penetration airtight.
7. Conduit Connection: 1/2-inch

C. Platinum RTD, Air Temperature Averaging Sensors:

1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 275 deg F
3. Multiple sensors to provide average temperature across entire length of sensor.
4. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
5. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch radius.
6. Length: As required by application to cover entire cross section of air tunnel.
7. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
8. Gasket for attachment to duct or equipment to seal penetration airtight.
9. Conduit Connection: 1/2-inch

D. Platinum RTD Outdoor Air Temperature Sensors:

1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 275 deg F
5. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.

E. Platinum RTD Space Air Temperature Sensors:

1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 212 deg F
3. Sensor assembly shall include a temperature sensing element mounted under a flush, brushed-aluminum cover.
4. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
5. Concealed wiring connection.

F. Space Air Temperature Sensors for Use with DDC Controllers Controlling Terminal Units:

1. 100 or 1000-ohm platinum RTD.
2. Temperature Transmitter Requirements:
   a. Mating transmitter required with each 100-ohm RTD.
   b. Mating transmitters optional for 1000-ohm RTD and thermistor, contingent on compliance with end-to-end control accuracy.
3. Provide digital display of sensed temperature.

2.3 AIR TEMPERATURE SWITCHES

A. Thermostat and Switch for Low Temperature Control in Duct Applications:

1. Description:
   a. Two-position control.
   b. Field-adjustable set point.
   d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Performance:
   a. Operating Temperature Range: 15 to 55 deg F.
   b. Temperature Differential: 5 deg F, non-adjustable and additive.
   c. Enclosure Ambient Temperature: Minus 20 to 140 deg F.
   d. Sensing Element Maximum Temperature: 250 deg F.
   e. Voltage: 120-V ac.
   f. Current: 16 FLA.
   g. Switch Type: Two SPDT snap switches operate on coldest 12-inch section along element length.

3. Construction:
   a. Vapor-Filled Sensing Element: Nominal 20 feet long.
   b. Dual Temperature Scale: Fahrenheit and Celsius visible on face.
   c. Set-Point Adjustment: Screw.
   d. Enclosure: Painted metal, NEMA 250, Type 1.
   e. Electrical Connections: Screw terminals.
   f. Conduit Connection: 1/2-inch trade size.

2.4 AIR TEMPERATURE RTD TRANSMITTERS

A. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.

B. House electronics in NEMA 250 enclosure.

1. Duct: Type 3.
2. Outdoor: Type 4X.
3. Space: Type 1.

C. Conduit Connection: 1/2-inch

D. Functional Characteristics:

1. Input:
   a. 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
2. Span (Adjustable):

   a. Space: 40 to 90 deg F.
   b. Supply Air Cooling and Heating: 40 to 120 deg F.
   c. Supply Air Cooling Only: 40 to 90 deg F.
   d. Supply Air Heating Only: 40 to 120 deg F.
   e. Exhaust Air: 50 to 100 deg F.
   f. Return Air: 50 to 100 deg F.
   g. Mixed Air: Minus 40 to 140 deg F.
   h. Outdoor: Minus 40 to 140 deg F.

3. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc.

4. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F.

5. Match sensor with temperature transmitter and factory calibrate together.

E. Performance Characteristics:

   1. Calibration Accuracy: Within 0.1 percent of the span.
   2. Stability: Within 0.2 percent of the span for at least 6 months.
   3. Combined Accuracy: Within 0.5 percent.

2.5 LIQUID AND STEAM TEMPERATURE SENSORS, COMMERCIAL GRADE

A. RTD:

   1. Resistance temperature sensors shall comply with IEC 60751, Class B requirements.
   2. Platinum with a value of 100 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
   3. Encase RTD in a Type 316 stainless-steel sheath with a 0.25-inch OD.
   4. Provide two-wire, PTFE-insulated, nickel-coated, 22-gage stranded copper leads.
   5. Provide spring-loaded RTDs for thermowell installations.
   6. Performance Characteristics:

      a. Range: Minus 328 to 932 deg F.
      b. Interchangeable Accuracy: Within 0.54 deg F at 32 deg F.
      c. Stability: Within 0.05 percent maximum ice-point resistance shift after 1000 hours at 752 deg F.
      d. Hysteresis: Within 0.04 percent of range.
      e. Response Time: 62.8 percent of change in 4 seconds with water flowing across sensor at 3 fps.

B. Connection Heads:

   1. Housing: Low-copper cast-aluminum alloy, complying with NEMA 250, Type 4.
   2. Terminals: Six or eight as required by sensor.
   3. Conduit Connection: 1/2-inch trade size.
C. Assembly: Sensor manufacturer shall furnish sensor, thermowell, and sensor connection head to provide a matched assembly.

2.6 LIQUID AND STEAM TEMPERATURE TRANSMITTERS, COMMERCIAL GRADE

A. House electronics in NEMA 250, Type 4X enclosure.

B. Enclosure Connection: 1/2-inch trade size.

C. Functional Characteristics:
   1. Input: 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
   2. Default Span (Adjustable):
      a. Heating Hot Water: 32 to 212 deg F.
   3. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc.
   4. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F.
   5. Match sensor with temperature transmitter and factory calibrate together. Each matched sensor and transmitter set shall include factory calibration data traceable to NIST.

D. Performance Characteristics:
   1. Calibration Accuracy: Within 0.1 percent of the span.
   2. Stability: Within 0.2 percent of the span for at least 6 months.
   3. Combined Accuracy: Within 0.5 percent.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPERATURE INSTRUMENT APPLICATIONS

A. Air Temperature Sensors:
1. Duct, 100-ohm platinum RTD or 1000-ohm platinum RTD.
2. Outdoor, 100-ohm platinum RTD or 1000-ohm platinum RTD.
3. Space, 100-ohm platinum RTD or 1000-ohm platinum RTD.

B. Air Temperature Transmitters:
1. Duct, Air temperature RTD transmitter.
2. Outdoor, Air temperature RTD transmitter.
3. Space, Air temperature RTD transmitter.

C. Liquid and Steam Temperature Sensors:
1. Boiler System, Liquid and steam temperature sensor, commercial grade.

D. Liquid and Temperature Transmitters:
1. Boiler System, Liquid and steam temperature sensor, commercial grade.

3.3 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment.

C. Fastening Hardware:
1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner’s access, confirm unrestricted ladder placement is possible under occupied condition.

E. Corrosive Environments:
1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.
B. Furnish and install circuit breakers. Comply with requirements in Section 26 28 16 “Enclosed Switches and Circuit Breakers”.

C. Furnish and install power wiring. Comply with requirements in Section 26 05 19 “low-Voltage Electrical Power Conductors and Cables”.

D. Furnish and install raceways. Comply with requirements in Section 26 05 33 “Raceways and Boxes for Electrical Systems”.

3.5 TEMPERATURE INSTRUMENT INSTALLATIONS

A. Mounting Location:

1. Roughing In:
   a. Outline instrument mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
   b. Provide independent inspection to confirm that proposed mounting locations comply with requirements indicated and approved submittals.
      1) Indicate dimensioned locations with mounting height for all surface-mounted products on Shop Drawings.
      2) Do not begin installation without submittal approval of mounting location.
   c. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.

2. Install switches and transmitters for air and liquid temperature associated with individual air-handling units and associated connected ductwork and piping near air-handling units co-located in air-handling unit system control panel to provide service personnel a single and convenient location for inspection and service.

3. Install liquid and steam temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.

4. Install air temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.

5. Mount switches and transmitters on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Special Mounting Requirements:

1. Protect products installed outdoors from solar radiation, building and wind effect with stand-offs and shields constructed of Type 316 stainless.

2. Temperature instruments having performance impacted by temperature of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover matching the instrument cover.

C. Mounting Height:
1. Mount temperature instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.

2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code or state and Federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
   
a. Make every effort to mount at 60 inches.

D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

E. Space Temperature Sensor Installation:

1. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
3. In finish areas, recess electrical box within wall.
4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.
5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.

F. Outdoor Air Temperature Sensor Installation:

1. Mount sensor in a discrete location facing north.
2. Protect installed sensor from solar radiation and other influences that could impact performance.
3. If required to have a transmitter, mount transmitter remote from sensor in an accessible and serviceable location indoors.

G. Single-Point Duct Temperature Sensor Installation:

1. Install single-point-type, duct-mounted, supply- and return-air temperature sensors. Install sensors in ducts with sensitive portion of the element installed in center of duct cross section and located to sense near average temperature. Do not exceed 24 inches in sensor length.
2. Install return-air sensor in location that senses return-air temperature without influence from outdoor or mixed air.
3. Rigidly support sensor to duct and seal penetration airtight.
4. If required to have transmitter, mount transmitter remote from sensor at accessible and serviceable location.

H. Averaging Duct Temperature Sensor Installation:

1. Install averaging-type air temperature sensor for temperature sensors located within air-handling units, similar equipment, and large ducts with air tunnel cross-sectional area of 20 sq. ft. and larger.
2. Install sensor length to maintain coverage over entire cross-sectional area. Install multiple sensors where required to maintain the minimum coverage.
3. Fasten and support sensor with manufacturer-furnished clips to keep sensor taut throughout entire length.
4. If required to have transmitter, mount transmitter in an accessible and serviceable location.

I. Liquid Temperature Sensor Installation:

1. Assembly shall include sensor, thermowell and connection head.
2. For pipe NPS 4 and larger, install sensor and thermowell length to extend into pipe between 50 to 75 percent of pipe cross section.
3. For pipe smaller than NPS 4:
   a. Install reducers to increase pipe size to NPS 4 at point of thermowell installation.
   b. For pipe sizes NPS 2-1/2 and NPS 3, thermowell and sensor may be installed at pipe elbow or tee to achieve manufacturer-recommended immersion depth in lieu of increasing pipe size.
   c. Minimum insertion depth shall be 2-1/2 inches.
4. Install matching thermowell.
5. Fill thermowell with heat-transfer fluid before inserting sensor.
6. Tip of spring-loaded sensors shall contact inside of thermowell.
7. For insulated piping, install thermowells with extension neck to extend beyond face of insulation.
8. Install thermowell in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement. If top dead center location is not possible due to field constraints, install thermowell at location along top half of pipe.
9. For applications with transmitters, mount transmitter remote from sensor in an accessible and serviceable location from floor.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 26 05 53 “Identification for Electrical Systems”.

B. Install engraved phenolic nameplate with instrument identification.

3.7 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.8 CHECK-OUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check temperature instruments for proper location and accessibility.

C. Verify sensing element type and proper material.
D. Verify location and length.
E. Verify that wiring is correct and secure.

3.9 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer’s written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, “Field Testing of HVAC Control Components,” in the absence of specific requirements and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistance source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.
G. Occupancy Adjustments: When requested within 24 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Perform according to manufacturer's written instruction.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

END OF SECTION 23 09 31
SECTION 23 09 93 - SEQUENCE OF OPERATIONS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes control sequences for HVAC systems, subsystems, and equipment.

B. Related Requirements: Section 23 10 10 “Monitoring and Control System for HVAC”.

1.2 TERMINAL UNIT OPERATING SEQUENCE

A. Hot water Unit Heater, Cabinet Heater, and Radiator:
   1. Unit control valve shall modulate open to supply required heat to space to meet owner provided setpoint (70 degrees f) of the wall mounted space temperature sensor, setpoint shall be adjustable at the MCS panel.
   2. When space temperature setpoint has been met, unit control valve shall modulate shut.

1.3 VENTILATION SEQUENCE

A. HV-1:
   1. Unit shall operate in ventilation mode on schedule per owner provided schedule adjustable at the Monitoring and Control System (MCS) panel.
   2. Unit shall be interlocked with respective outdoor air damper.
      a. Modulating outdoor air damper shall be opened to minimum owner provided setpoint (6075 Cfm) adjustable at the MCS panel.
      b. Outdoor air damper shall have adjustable manual override capabilities at the MCS panel.
   3. HC-1 control valve shall modulate open to supply required heated air to space to meet owner provided setpoint (70 degrees f) of the wall mounted space temperature sensor, setpoint shall be adjustable at the MCS panel.
   4. When the space temperature setpoint has been met, HC-1 control valve shall modulate shut.
   5. Provide Alarm conditions as specified in Paragraph 1.6. Alarm condition shall be through the MCS interface and dry contact relay to the existing SCADA system. Final terminations to SCADA system, and SCADA programming shall be by owner.

B. HV-2:
   1. Unit shall operate continuously in ventilation mode.
   2. Unit shall be interlocked with respective outdoor air damper.
      a. Outdoor air damper shall be opened to maximum position (13280 cfm).
3. HC-2 control valve shall modulate open to supply required heated air to space to meet owner provided setpoint (70 degrees f) of the wall mounted space temperature sensor, setpoint shall be adjustable at the MCS panel.

4. When the space temperature setpoint has been met, hc-2 control valve shall modulate shut.

5. Provide Alarm conditions as specified in Paragraph 1.6. Alarm condition shall be through the MCS interface and dry contact relay to the existing SCADA system. Final terminations to SCADA system, and SCADA programming shall be by owner.

C. HV-3:

1. Unit shall operate in heating or cooling mode as determined by adjustable setpoint of the wall mounted space temperature sensor.
   a. Wall mounted space temperature sensor shall have digital readout with local temperature override capabilities (+/- 5 degrees).

D. S-1:

1. Unit shall operate with both REF-2 and REF-3.
   a. Unit shall operate at low speed when either REF-2 or REF-3 is operating.
   b. Unit shall switch to high speed when both REF-2 and REF-3 are operating simultaneously.

2. Unit shall be interlocked with 4’x10’ outdoor air damper on floor above and return air damper in space.
   a. If outdoor air temperature is lower than owner provided setpoint (80 degrees f) adjustable at the MCS panel, modulating outdoor air damper shall open to minimum position (3125 cfm) when s-1 is operating at low speed and open to maximum position (6250 cfm) when s-1 is operating at high speed, return air damper shall be closed.
   b. If outdoor air temperature is higher than owner provided setpoint (81 degrees f) adjustable at the MCS panel, modulating outdoor air damper shall close, return air damper shall open to maximum position (6250 cfm), and REF-2 and REF-3 shall shut off.

E. S-2:

1. Unit shall operate when door contact is opened.
   a. Unit shall run for owner provided amount of time (30 minutes) adjustable at the MCS panel.

2. Unit shall operate on a time schedule.
   a. Unit shall run for owner provided amount of time (30 minutes) adjustable at the MCS panel every (2 hours) adjustable at the MCS panel.

3. Unit shall be interlocked with 2’x1’4” outdoor air damper in room.
   a. Outdoor air damper to open to maximum position (250 cfm) when S-2 is operating.
1.4 EXHAUST SEQUENCE

A. REF-2:
   1. Unit shall operate when wall mounted space temperature sensor reading exceeds owner provided setpoint (70 degrees f) adjustable at the MCS panel and outdoor air temperature is less than owner provided setpoint (80 degrees f) adjustable at the MCS panel.

B. REF-3:
   1. Unit shall operate when wall mounted space temperature sensor reading exceeds owner provided setpoint (70 degrees f) adjustable at the MCS panel and outdoor air temperature is less than owner provided setpoint (80 degrees f) adjustable at the MCS panel.

C. REF-2/REF-3:
   1. If either wall mounted temperature sensor reading exceeds owner provided setpoint (85 degrees f) adjustable at the MCS panel, both REF-2 and REF-3 shall operate.

D. REF-4:
   1. Unit shall operate when HV-1 is operating.
   2. VFD shall modulate airflow based on pressure sensor in space to keep a negative (-0.01) space pressure adjustable at the MCS panel.
   3. Provide Alarm conditions as specified in Paragraph 1.6. Alarm condition shall be through the MCS interface and dry contact relay to the existing SCADA system. Final terminations to SCADA system, and SCADA programming shall be by owner.

E. REF-5:
   1. Unit shall operate when wall mounted space temperature sensor exceeds owner provided setpoint (80 degrees f) adjustable at the MCS panel and outdoor air temperature is less than owner provided setpoint (80 degrees f) adjustable at the MCS panel.
   2. Unit shall be interlocked with 1’x8’ outdoor air damper in room.
      a. Outdoor air damper to open to maximum position (1200 cfm) when REF-5 is operating.

F. E-1:
   1. Unit shall operate continuously.
   2. Provide Alarm conditions as specified in Paragraph 1.6. Alarm condition shall be through the MCS interface and dry contact relay to the existing SCADA system. Final terminations to SCADA system, and SCADA programming shall be by owner.

G. E-2:
   1. Unit shall operate when gas detection system is in alarm.
   2. Unit shall operate when wall mounted override button is pushed.
      a. Override time shall be adjustable at the MCS panel.
3. Unit shall be interlocked with 9'x8' outdoor air damper and 5'-6"x9' outdoor air damper located in room.
   a. Both outdoor air dampers shall open to maximum positions when e-2 is operating.
4. Provide Alarm conditions as specified in Paragraph 1.6. Alarm condition shall be through the MCS interface and dry contact relay to the existing SCADA system. Final terminations to SCADA system, and SCADA programming shall be by owner.

1.5 HEATING SYSTEM SEQUENCE

A. P-3 & P-4:
   1. Units to run as lead-lag pumps.
      a. Differential pressure sensors shall sense loss of pressure upon pump failure and automatically switch over.
      b. Pumps shall automatically alternate operation every 24 hours of runtime, adjustable at the MCS panel.

B. B-1:
   1. Gas fired hot water boiler shall be enabled whenever the boiler is scheduled on and at least one hot water coil in the system is modulating open or when the outside air is below owner provided setpoint (60 degrees f) adjustable at the MCS panel and at least one hot water coil in the system is modulating open.
   2. Boiler shall stage firing based on demand.

1.6 SCADA ALARM CONDITIONS

A. The MCS shall notify the SCADA system of the following alarm conditions (ensure all contacts required are included for the following):
   1. Heating/ventilating unit (HV-1 and HV-2) fault condition/failure to run.
   2. Exhaust Fan (E-1 and E-2) fault condition/failure to run.
   3. Gas detection fault condition.
   4. Fire alarm fault condition.
   5. Space Temperature below 38 Degrees F.
   6. Space Temperature above 95 Degrees F.

B. The MCS shall initiate exterior building alarms for the following alarm conditions:

C. The MCS shall initiate interior building alarms for the following alarm conditions:
   1. Fire Indication – Red Lamp and Horn.
1.7 EXISTING EQUIPMENT

A. The MCS shall control all existing HVAC equipment as shown on drawings.
B. The sequence of operations for existing equipment shall remain unchanged.

1.8 GRAPHICS

A. The following minimum items shall be visible on the MCS panel touch screen interface:
   1. DDC system graphic for each piece of equipment, with all adjustable setpoints described above.
   2. DDC system status, on-off, occupied-unoccupied for each piece of equipment.
   3. Time schedule.
   4. Outdoor-air temperature.
   5. Damper positions.
   6. Damper setpoints.
   7. Fan status and command.
   8. VFD status and command.
   9. Heating and cooling command and status.
  10. Room temperature for each space.
  11. Temperature setpoint for each space.
  12. Duct Airflows (EF-1 and EF-2).
  13. Space pressure setpoint.
  14. Circulating pump(s) on-off status (enabled or disabled).
  15. Circulating pump(s) on-off indication (operating or not operating).
  16. Circulating pump(s) pressure differential set point.
  17. Alarm (circulating pump(s) failure).
  21. Heating-water supply temperature set point.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 09 93
SECTION 23 10 10 - MONITORING AND CONTROL SYSTEM (MCS) FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

Provide a Monitoring and Control System (MCS) which performs supervisory monitoring and supervisory control of building heating and ventilation systems using one or more of: ASHRAE 135 (BACnet), Modbus, or the Niagara Framework as indicated and shown.

A. System Requirements

Provide a MCS as specified and indicated, and in accordance with the following characteristics:

1. General System Requirements

   a. The system performs supervisory monitoring and control functions including but not limited to Scheduling, Alarm Handling, Overrides, and Settings Adjustments as specified.
   b. The system includes a 10" (minimum) Touch Screen Graphical User Interface, integrated into a NEMA wall mounted cabinet, which allows for graphical navigation between systems, graphical representations of systems, access to real-time data for systems, ability to override points in a system, and access to all supervisory monitoring and control functions.
   c. All software used by the MCS and all software used to install and configure the MCS is licensed to and delivered to RRWRD.
   d. All necessary documentation, configuration information, configuration tools, programs, drivers, and other software is licensed to and otherwise remains with the owner such that the owner or their agents are able to repair, replace, upgrade, and expand the system without subsequent or future dependence on the Contractor. Software licenses must not require periodic fees and must be valid in perpetuity.
   e. Provide sufficient documentation and data, including rights to documentation and data, such that the owner or their agents can execute work to repair, replace, upgrade, and expand the system without subsequent or future dependence on the Contractor.
   f. The MCS interfaces directly to ASHRAE 135, Modbus, or Niagara Framework field control systems and may interface to field control systems using other protocols via a Monitoring and Control (M&C) Controller Hardware, Software protocol driver, or a Gateway.
   g. For MCS systems with Monitoring and Control Software functionality implemented in, provide sufficient additional controller hardware to support the full capacity requirements as specified.

2. Symbols, Definition and Abbreviations

   Use symbols, definitions, and engineering unit abbreviations indicated in the contract drawings for displays, submittals and reports. For symbols, definitions and abbreviations not in the contract drawings use terms conforming at a minimum to IEEE Stds Dictionary and the ASHRAE FUN IP, as applicable.

3. System Units and Accuracy

   Use English (inch-pound) units for displays, graphics and calculations. Perform calculations with an accuracy of at least three significant figures. For displays present values to at least two significant figures.
1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

**AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)**

ASHRAE 135 (2016; INT 1 2016; ERTA 1 2016) BACnet—A Data Communication Protocol for Building Automation and Control Networks


**CONSUMER ELECTRONICS ASSOCIATION (CEA)**


**INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)**


**INTERNET ENGINEERING TASK FORCE (IETF)**


RFC 821 (2001) Simple Mail Transfer Protocol (SMTP)

**MODBUS ORGANIZATION, INC (MODBUS)**


**NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)**

NEMA 250 (2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
1.3 DEFINITIONS

The following list of definitions may contain terms not found elsewhere in this Section but are included here for completeness. Some terms are followed with a protocol reference in parenthesis indicating to which protocol the term and definition applies. Inclusion of protocol-specific definitions does not create a requirement to support that protocol, nor does it relax any requirements to support specific protocols as indicated elsewhere in this section.

A. Alarm Generation - The process of comparing a point value (the point being alarmed) with a predefined alarm condition (e.g. a High Limit) and performing some action based on the result of the comparison.

B. Alarm Handling - see Alarm Routing
C. Alarm Routing - Alarm routing is M&C software functionality that starts with a notification that an alarm exists (typically as the output of an Alarm Generation process) and sends a specific signal or message to a specific alarm recipient or device.

D. BACnet (BACnet) - The term BACnet is used in two ways. First meaning the BACnet Protocol Standard - the communication requirements as defined by ASHRAE 135 including all annexes and addenda. The second to refer to the overall technology related to the ASHRAE 135 protocol.

E. BACnet Advanced Application Controller (B-AAC)(BACnet) - A hardware device BTL Listed as a B-AAC. A control device which contains BIBBs in support of scheduling and alarming but otherwise has limited resources relative to a B-BC. It may be intended for specific applications and supports some degree of programmability.

F. BACnet Application Specific Controller (B-ASC)(BACnet) - A hardware device BTL Listed as a B-ASC. A controller with limited resources relative to a B-AAC. It is intended for use in a specific application and supports limited programmability.

G. BACnet Building Controller (B-BC)(BACnet) - A hardware device BTL Listed as a B-BC. A general-purpose, field-programmable device capable of carrying out a variety of building automation and control tasks including control and monitoring via direct digital control (DDC) of specific systems and data storage for trend information, time schedules, and alarm data. Like the other BTL Listed controller types (B-AAC, B-ASC etc.) a B-BC device is required to support the server ("B") side of the ReadProperty and WriteProperty services, but unlike the other controller types it is also required to support the client ("A") side of these services. Communication between controllers requires that one of them support the client side and the other support the server side, so a B-BC is often used when communication between controllers is needed.

H. BACnet Internetwork (BACnet) - Two or more BACnet networks connected with BACnet routers. In a BACnet Internetwork, there exists only one message path between devices.

I. BACnet Interoperability Building Blocks (BIBBs) (BACnet) - A BIBB is a collection of one or more BACnet services intended to define a higher level of interoperability. BIBBs are combined to build the BACnet functional requirements for a device in a specification. Some BIBBs define additional requirements (beyond requiring support for specific services) in order to achieve a level of interoperability. For example, the BIBB DS-V-A (Data Sharing-View-A), which would typically be used by an M&C client, not only requires the client to support the ReadProperty Service, but also provides a list of data types (Object / Properties) which the client must be able to interpret and display for the user.

J. BACnet Operator Display (B-OD)(BACnet) - A hardware device BTL Listed as a B-OD. A basic operator interface with limited capabilities relative to a B-OWS. It is not intended to perform direct digital control. The B-OD profile could be used for wall-mounted LCD devices, displays affixed to BACnet devices; hand-held terminals or other very simple user interfaces.

K. BACnet Operator Workstation (B-OWS)(BACnet) - Monitoring and Control (M&C) Software BTL Listed as a B-OWS. An operator interface with limited capabilities relative to a B-AWS. The B-OWS is used for monitoring and basic control of a system, but differs from a B-AWS in that it does not support configuration activities, nor does it provide advanced troubleshooting capabilities.

L. BACnet Smart Actuator (B-SA)(BACnet) - A hardware device BTL Listed as a B-SA. A simple control output device with limited resources; it is intended for specific applications.
M. BACnet Smart Sensor (B-SS)(BACnet) - A hardware device BTL Listed as a B-SS. A simple sensing device with very limited resources.

N. BACnet Testing Laboratories (BTL)(BACnet) - Established by BACnet International to support compliance testing and interoperability testing activities and consists of BTL Manager and the BTL Working Group (BTL-WG). BTL also publishes Implementation Guidelines.

O. BACnet Testing Laboratories (BTL) Listed (BACnet) - A device that has been certified by BACnet® Testing Laboratory. Devices may be certified to a specific device profile, in which case the certification indicates that the device supports the required capabilities for that profile, or may be certified as "other".

P. Binary - A two-state system or signal; for example one where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

Q. Broadcast - Unlike most messages, which are intended for a specific recipient device, a broadcast message is intended for all devices on the network.

R. Building Control System (BCS) - One type of Field Control System. A control system for building electrical and mechanical systems, typically HVAC (including central plants) and lighting. A BCS generally uses Direct Digital Control (DDC) Hardware and generally does NOT include its own local front end.

S. Commandable (BACnet) - A point (Object) is commandable if its Present_Value Property is writable and it supports the optional Priority_Array Property. This functionality is useful for Overrides.

T. Control Logic Diagram - A graphical representation of control logic for multiple processes that make up a system.

U. Device Object (BACnet) - Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object_Identifier number on the BACnet internetwork. This number is often referred to as the device instance or device ID.

V. Field Point Of Connection (FPOC) - The FPOC is part of the MCS IP network and acts as the point of connection between the MCS IP Network and the field control IP network. The FPOC is an IT device such as a switch, IP router, or firewall, typically managed by the site IT staff. (Note that the field control IP network may consist of a single IP device, or that integration may require installation of a field control network IP device.)

W. Field Control Network - The network used by a field control system.

X. Field Control System (FCS) - A building control system or utility control system.

Y. Gateway - A device that translates from one protocol to another.

Z. JACE (Niagara Framework) - Java Application Control Engine. See Niagara Framework Supervisory Gateway

AA. Modbus - A basic protocol for control network communications generally used in utility control systems. The Modbus protocol standard is maintained by The Modbus Organization.
BB. Monitoring and Control (M&C) Software - The MCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

CC. Network (BACnet) - In BACnet, a portion of the control internetwork consisting of one or more segments of the same media connected by repeaters. Networks are separated by routers.

DD. Niagara Framework - A set of hardware and software specifications for building and utility control owned by Tridium Inc. and licensed to multiple vendors. The Framework consists of front end (M&C) software, web based clients, field level control hardware, and engineering tools. While the Niagara Framework is not adopted by a recognized standards body and does not use an open licensing model, it is sufficiently well-supported by multiple HVAC vendors to be considered a de-facto Open Standard.

EE. Niagara Framework Supervisory Gateway (Niagara Framework) - DDC Hardware component of the Niagara Framework. A typical Niagara architecture has Niagara specific supervisory gateways at the IP level and other (non-Niagara specific) controllers on field networks (TP/FT-10, MS/TP, etc.) beneath the Niagara supervisory gateways. The Niagara specific controllers function as a gateway between the Niagara framework protocol (Fox) and the field network beneath. These supervisory gateways may also be used as general purpose controllers and also have the capability to provide a web-browser based user interface. Note that different vendors refer to this component by different names. The most common name is "JACE"; other names include "EC-BOS", "FX-40", and "UNC".

FF. Object (BACnet) - A BACnet Object. The concept of organizing BACnet information into standard components with various associated Properties. Examples include Analog Input objects and Binary Output objects.

GG. Override - To change the value of a point outside of the normal sequence of operation where this change has priority over the sequence. An override can be accomplished in one of two ways: the point itself may be Commandable and written to with a priority or there may be a separate point on the controller for the express purpose of implementing the override. Typically this override is from the Monitoring and Control System (MCS) Monitoring and Control (M&C) Software. Note that this definition is not standard throughout industry.

HH. Point, Calculated - A value within the M&C Software that is not a network point but has been calculated by logic within the software based on the value of network points or other calculated points. Calculated points are sometimes called virtual points or internal points.

II. Point, Network - A value that the M&C Software reads from or writes to a field control network.

JJ. Polling - A requested transmission of data between devices, rather than an unrequested transmission such as Change-Of-Value (COV) or Binding where data is automatically transmitted under certain conditions.

KK. Property (BACnet) - A BACnet Property - a data element associated with an Object. Different Objects have different Properties, for example an Analog Input Object has a Present_Value Property (which provides the value of the underlying hardware analog input), a High_Limit Property (which contains a high limit for alarming), as well as other properties.

LL. Protocol Implementation Conformance Statement (PICS)(BACnet) - A document, created by the manufacturer of a device, which describes which portions of the BACnet standard are implemented by a given device.
MM. Repeater - A device that connects two control network segments and retransmits all information received on one side onto the other.

NN. Router (BACnet) - A device that connects two or more BACnet networks and controls traffic between the networks by retransmitting signals received from one network onto another based on the signal destination. Routers are used to subdivide an internetwork and to control bandwidth usage.

OO. Segment - A 'single' section of a control network that contains no repeaters or routers. There is generally a limit on the number of devices on a segment, and this limit is dependent on the topology/media and device type. For example, a TP/FT-10 segment with locally powered devices is limited to 64 devices, and a BACnet MS/TP segment is limited to 32 devices.

PP. Service (BACnet) - A BACnet Service. A defined method for sending a specific type of data between devices. Services are always defined in a Client-Server manner, with a Client initiating a Service request and a Server Executing the Service. Some examples are ReadProperty (a client requests a data value from a server), WriteProperty (a client writes a data value to a server), and CreateObject (a client requests that a server create a new object within the server device).

QQ. Standard BACnet Object/Property/Service (BACnet) - BACnet Objects, Properties, or Services that are standard Objects, Properties, or Services enumerated and defined in ASHRAE 135. Clause 23 of ASHRAE 135 defines methods to extend ASHRAE 135 to non-standard or proprietary information. Standard BACnet Objects/Properties/Services specifically exclude any vendor specific extensions.

RR. Supervisory Controller - A controller implementing a combination of supervisory logic (global or optimization strategies), scheduling, alarming, event management, trending, web services or network management. Note this is defined by use; many supervisory controllers have the capability to also directly control equipment.

SS. Supervisory Gateway - A device that is both a supervisory controller and a gateway, such as a Niagara Framework Supervisory Gateway.

TT. MCS Network - An IP network connecting multiple field control systems to the Monitoring and Control Software using one or more of: BACnet (ASHRAE 135 Annex J), or Modbus.

UU. Utility Control System (UCS) - SCADA field control system. Used for control of utility systems such as an electrical substation, sanitary sewer lift station, water pump station, etc. Building controls are excluded from a UCS, however it is possible to have a Utility Control System and a Building Control System in the same facility, and for those systems to share components such as the FPOC. A UCS may include its own local front-end.

1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

A. Shop Drawings

1. MCS Contractor Design Drawings - MCS Contractor Design Drawings as a single complete package: 3 hard copies and 1 electronic copy. Submit hardcopy drawings on A3 17 by 11 inches sheets, and electronic drawings in both PDF and AutoCAD format.
2. Final As-Built Drawings - Final As-Built Drawings as a single complete package: Three hard copies and one electronic copy. Submit hardcopy drawings on A3 17 by 11 inches sheets, and electronic drawings in both PDF and AutoCAD format.

B. Product Data

1. Product Data Sheets
2. Computer Software - The most recent versions of all computer software provided under this specification delivered as a Technical Data Package. Submit the user manuals for all software delivered for this project with the software.

C. Enclosure Keys

D. Test Reports

1. Pre-Construction QC Checklist - Four copies of the Pre-Construction QC Checklist.
3. Factory Test Procedures - Four copies of the Factory Test Procedures. The Factory Test Procedures may be submitted as a Technical Data Package.
5. Existing Conditions Report - Four copies of the Existing Conditions Report.

E. Operation and Maintenance Data

1. Operation and Maintenance (O&M) Instructions – Four bound O&M Instructions and 1 copies of the Instructions in PDF format on optical disc. Index and tab bound instructions. O&M Instructions may be submitted as a Technical Data Package.
3. Basic Training Documentation - Training manuals for Basic Training delivered for each trainee on the Course Attendance List with two additional copies delivered for archival at the project site. Submit two copies of the Course Attendance List with the archival copies. The Basic Training Documentation may be submitted as a Technical Data Package.
4. Advanced Training Documentation - One set of training manuals delivered for each trainee on the Course Attendance List with two additional copies delivered for archival at the project site. Submit two copies of the Course Attendance List with the archival copies. The Advanced Training Documentation may be submitted as a Technical Data Package.

1.5 QUALITY CONTROL (QC) CHECKLISTS

The Contractor's Quality Control (QC) Representative must complete the QC Checklist in APPENDIX A, and must submit the Pre-Construction QC Checklist, Post-Construction QC Checklist and Closeout QC Checklist as specified. The QC Representative must verify each item in the Checklist and initial in the provided area to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Owner.

1.6 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

F. Provide MCS Operation and Maintenance Instructions which include:
1. Procedures for the MCS system start-up, operation and shut-down.
2. Final As-Built drawings.
3. Routine maintenance checklist, arranged in a columnar format: The first column listing all installed devices, the second column stating the maintenance activity or stating that no maintenance required, the third column stating the frequency of the maintenance activity, and the fourth column providing any additional comments or reference.
4. Qualified service organization list including points of contact with phone numbers.
6. Performance Verification Test (PVT) Procedures and Reports.

PART 2 - PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

A. Product Certifications

For computing devices, as defined in FCC Part 15, supplied as part of the MCS provide devices which are certified to comply with the requirements of Class B computing devices.

B. Product Sourcing

For units of the same type of equipment, provide products of a single manufacturer. For each major component of equipment provide equipment with the manufacturer's name and the model and serial number in a conspicuous place. For materials and equipment, provide new standard unmodified products of a manufacturer regularly engaged in the manufacturing of such products.

C. General Requirements

1. Provide components that meet the following requirements:

a. Portions of the data communications equipment system installed in unconditioned spaces must operate properly in an environment with ambient temperatures between 32 and 120 degrees F and ambient relative humidity between 10 percent and 90 percent noncondensing.

b. Components must accept 100 to 125 volts AC (Vac), 60 Hz, single phase, dedicated circuit or be provided with a transformer to meet the component's power requirements.

c. The equipment must meet the requirements of NFPA 70, UL 60950, NFPA 262, FCC EMC, and FCC Part 15.

d. The equipment shall be a UL Listed assembly.

D. Nameplates

Provide nameplates of laminated plastic identifying the function, network address, if applicable, and identifier of the device. Laminated plastic must be at least 0.125 inch thick, white with black center core. Nameplates must be a minimum of 1 by 3 inch with minimum 0.25 inch high engraved block lettering.

E. Product Data Sheets

For all products (equipment) specified in PART 2 and supplied under this contract, submit copies of all manufacturer catalog cuts and specification sheets to indicate conformance to product requirements. For M&C Software also include the PICS verifying BTL Listing as a B-AWS.
2.2 CONTROL HARDWARE

A. Control Protocol Routers

1. BACnet/IP Router

Provide BACnet/IP Routers which perform layer 3 routing of ASHRAE 135 packets over an IP network in accordance with ASHRAE 135 Annex J and Clause 6. The router must provide the appropriate connection to the IP network and connections to a ASHRAE 135 MS/TP network. Devices used as BACnet/IP Routers must be BTL Listed and must support the Network Management-Router Configuration-B (NM-RC-B) BIBB.

B. Monitoring and Control (M&C) Controller Hardware

Provide Monitoring and Control (M&C) Controller Hardware which is a microprocessor-based direct digital control hardware and which communicates over the MCS IP network using ASHRAE 135 in accordance with ASHRAE 135 Annex J and using only Standard ASHRAE 135 services.

C. BACnet Supervisory Controller Hardware

Provide BACnet Supervisory Controller Hardware which is direct digital control hardware and which:

1. is BTL Listed
2. communicates using ASHRAE 135 over an IP network in accordance with ASHRAE 135 Annex J
3. has a configurable Object_Name Property
4. supports the following BIBBS
   a. DS-RP-B (Data Sharing–Read Property–B) BIBB for Objects requiring read access from the M&C Software
   b. DS-WP-B (Data Sharing–Write Property–B) BIBB for Objects requiring write access from the M&C Software.
   c. SCHED-E-B (Scheduling-External-B)
   d. AE-N-I-B (Alarm and Event-Notification Internal-B)
   e. AE-ACK-B (Alarm and Event-ACK-B)
   f. T-VMT-I-B (Trending-Viewing and Modifying Trends-Internal-B)
   g. T-ATR-B (Trending-Automated Trend Retrieval-B)

5. has a Writeable Recipient List Property of the Notification Class Object
6. Gateway for ASHRAE 135

For gateways using ASHRAE 135 provide gateways which meets the following requirements in addition to the requirements for all gateways:

a. It must allow bi-directional mapping of data in the Gateway to Standard Objects as defined in ASHRAE 135.
b. All ASHRAE 135 Objects must have a configurable Object_Name Property.
c. It must be BTL Listed.
d. Gateways communicating ASHRAE 135 over an IP network must communicate in accordance with ASHRAE 135 Annex J.
e. Gateways communicating ASHRAE 135 to a field control system must support the DS-RP-A (Data Sharing–Read Property–A) BIBB and the DS-WP-A (Data Sharing–Write Property–A) BIBB.
f. Gateways communicating ASHRAE 135 to the M&C Software or to a BACnet Supervisory Controller must support the DS-RP-B (Data Sharing–Read Property–B) BIBB for Objects

Not to be used for bidding purposes
requiring read access from the M&C Software and the DS-WP-B (Data Sharing–Write Property–B) BIBB for Objects requiring write access from the M&C Software.

7. Niagara Framework Supervisory Gateway

Niagara Framework Supervisory Gateway Hardware must:

a. be direct digital control hardware.
b. have an unrestricted interoperability license and a Niagara Compatibility Statement (NiCS) that follows the Tridium Open NiCS Specification.
c. manage communications between a field control network and the Niagara Framework Monitoring and Control Software and between itself and other Niagara Framework Supervisory Gateways. Niagara Framework Supervisory Gateway Hardware must use Fox protocol for communication with other Niagara Framework Components.
d. be fully programmable using the Niagara Framework Engineering Tool and support the following:
   (1) Time synchronization, Calendar, and Scheduling using Niagara Scheduling Objects
   (2) Alarm generation and routing using the Niagara Alarm Service
   (3) Trending using the Niagara History Service and Niagara Trend Log Objects
   (4) Integration of field control networks using the Niagara Framework Engineering Tool
   (5) Configuration of integrated field control system using the Niagara Framework Engineering Tool when supported by the field control system

e. meet the following minimum hardware requirements:
   (1) 10/100 Mbps Ethernet Port
   (2) One port compatible with the field control system to be integrated using this product.

f. provide access to field control network data and supervisory functions via web interface and support a minimum of 16 simultaneous users.

2.3 COMPUTER HARDWARE

For computer hardware furnished under this specification provide standard products of a single manufacturer which advertises service in all 48 contiguous states, and provide only model currently in production. Except for PCI-E cards installed into expansion slots provided in a desktop or server computer in order to meet the requirements of this specification, do not modify computer hardware from the manufacturer configuration.

A. Hardware

Computing Hardware, and/or devices must be completely integrated into the control cabinet and must be of sufficient processing power and memory capacity to meet the performance requirements of this specification.

2.4 COMPUTER SOFTWARE

A. Operating System (OS)

All operating system software shall be included with MCS. Provide the owner with the original Operating System license.
B. M&C Controller Hardware Configuration Software

Provide M&C Controller Hardware Configuration Software consisting of the software required to configure, program, or configure and program each Monitoring and Control (M&C) Controller Hardware provided for the functions it performs.

C. BACnet Network Browser

1. Provide a BACnet Network Browser software that:
   a. Can perform full discovery of a ASHRAE 135 system including but not limited to discovery of all ASHRAE 135 devices, the ASHRAE 135 Objects and Properties of each device, and the standard ASHRAE 135 services supported by each device.
   b. Can read any ASHRAE 135 Property of any Object in any device. Proprietary Properties may be presented as read without further interpretation.
   c. Can write any Standard ASHRAE 135 Property of any Object in any device.
   d. Supports segmentation.
   e. Supports all of the following BIBBs:
      (1) DM-ANM-A (Device Management-Automatic Network Management-A)
      (2) DM-ADM-A (Device Management-Automatic Device Management-A)
      (3) DM-DDB-A (Device Management-Dynamic Device Binding-A)
      (4) DM-DOB-A (Device Management-Dynamic Object Binding-A)
      (5) DS-RP-A (Data Sharing-Read Property-A)
      (6) DS-RPM-A (Data Sharing-Read Property Multiple-A)
      (7) DS-WP-A (Data Sharing-Write Property-A)

D. Niagara Framework Engineering Tool (If Used)

2. Provide Niagara Workbench or an equivalent Niagara Framework engineering tool software which:
   a. has unrestricted interoperability license and a Niagara Compatibility Statement (NiCS) which follows the Tridium Open NiCS Specification.
   b. is capable of performing network configuration for Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.
   c. is capable of programming and configuring Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.
   d. is capable of discovery of Niagara Framework Supervisory Gateways and all points mapped into each Niagara Framework Supervisory Gateway and making these points accessible to Niagara Framework Monitoring and Control Software.

E. Monitoring and Control (M&C) Software

1. Provide Monitoring and Control (M&C) software which is a client-server software package with a graphical user interface (GUI) through touch screen interactivity. A Niagara Framework Web Supervisor or equivalent Niagara Framework monitoring and control software which communicates with Niagara Framework field control systems may be used which communicates via ASHRAE 135, or provide M&C Software which is BACnet Testing Laboratories Certified ("Listed") as a B-AWS. The M&C Software may support other field control protocols.

2. Provide a single software package which implements the Scheduling, Alarming, Trending, Graphical System Display, and System Display Editor functionality. Other specified M&C
functionality may be implemented in the same software package or in additional software packages. As specified in PART 3 EXECUTION, the M&C Software must operate on Server hardware, except that software for Point Calculations and Demand Limiting may operate on M&C Controller Hardware.

3. M&C Software License

a. License the M&C Software as specified. Use of multiple copies of M&C Server software working in coordination and sharing data between them such that they function as, and appear to an operator as, a single M&C Server is permitted to meet these requirements.

F. Network Points

1. For Niagara Framework systems, a network point is a point brought directly into the Web Supervisor M&C Software via a Niagara Framework Supervisory Gateway. Provide M&C Software and licensing to support no less than 100 network points, and to be capable of expansion to support no less than 1,000 network points.

G. Other Points

1. For installations using M&C Software installed on M&C Controller Hardware (as opposed to Server hardware), provide additional licensing to support additional network points for the communications between portions of the M&C Software installed on different hardware. For example, if the Calculations requirement is performed by M&C Software installed on Controller hardware, the M&C Software must be licensed for additional network points to cover the network points required for communication between the Controller hardware and the Server hardware.

H. Alarming

1. Provide M&C Software and licensing to support the handling (routing) of alarms for no less than 10 points and ASHRAE 135 Alarm Event Notifications to the existing SCADA system through a set of contacts for each alarm.

I. Trending

1. Provide M&C Software and licensing to support a minimum of 1,000 simultaneous trends.

J. M&C Software Update Licensing

1. In addition to all other licensing requirements, provide M&C Software licensing which includes licensing of the following software updates for a period of no less than 5 years:
   a. Security and bug-fix patches issued by the M&C Software manufacturer.
   b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

2. Supported Field Control Protocols - Provide M&C Software which supports field control protocols as follows:
   a. The M&C Software must include a driver to ASHRAE 135 over IP in accordance with ASHRAE 135 Annex J.
b. The Software may use the Niagara Framework and may communicate with Niagara Framework Supervisory Gateways using the Fox protocol.
c. The M&C Software may, in addition, include drivers to other protocols.

(1) Provide M&C Software capable of reading values from and writing values to points via any supported field protocol, and capable of reading values from one field protocol and writing them to another. All points obtained from any field protocol must be available to all M&C Software functionality.

3. Point Information - Every point, both network and internal, in the M&C Software must contain the following fields:
   a. Name - A configurable name used for identification of the point within the M&C Software.
   b. Description - A configurable description of no less than 80 alpha-numeric characters.
   c. Value - A field containing the current point value.
   d. Units - A field containing the engineering units.
   e. Source - A field identifying the source of the point. For network points, this is generally the address or identification of the field device (for example, the DeviceID for BACnet devices).

4. Point Calculations
   a. Provide M&C software capable of performing calculations and computing the value of a calculated point based on the values of two or more network points and calculated points. Mathematical operators must include: addition, subtraction, multiplication, division, exponentiation \((y^x, \text{power})\), square root, reciprocal, natural logarithm, \(\sin\), \(\cos\), \(\tan\), \(\arcsin\), \(\arccos\), \(\arctan\), and parenthesis. \(\pi\) and \(e\) must be available as constants for use in calculations.

K. Touch Screen Graphical User Interface (GUI)

Provide M&C Software which includes a touch screen graphical user interface through which all M&C Software functionality, except for the Graphics Editor, System Display Editor, report configuration, point calculation configuration, and enterprise protocol configuration, is accessible.

1. Passwords - Provide M&C software with user-based access control to M&C functionality. The M&C Software must recognize at least 10 separate users and have at least 2 levels of user permissions. User permission levels (from most restrictive to most permissive) must include:
   a. Permission Level 1: View-only access to the graphical user interface plus acknowledge alarms and set up (configure) trends and reports.
   b. Permission Level 2: Permission Level 1 plus override points and set up (configure) alarms, schedules and demand limiting, plus create and modify Graphical System Displays using the System Display Editor.

Passwords must not be displayed and must not be logged. The system must maintain a disk file on the server hardware logging all activity of the system. This file must maintain, as a minimum, a record of all operators logged onto the system, alarm acknowledgments, commands issued and all database modifications. If the file format is not plain ASCII text, provide a means to export or convert the file to plain ASCII text. Provide a mechanism for archiving the log files for long term record storage.
2. Graphical System Displays - Provide graphical displays consisting of building systems (make-up air handler units, exhaust units, unit heaters, gas detection devices, etc.) graphic displays. Data associated with an active display must be updated at least once every 5 seconds.

a. Navigation Scheme - System graphic displays of building systems and points must be hierarchical displays using a building-to-equipment touch-and-click navigation scheme which allows navigation through a building-wide display to the individual units. Each display must show system wide data such as outside air temperature, hydrogen sulfide and methane levels.

b. Show the building footprint and basic floor plan, and clearly show and distinguish between the individual zones and the equipment serving each zone and space. Show all space sensor and status readings, as applicable, for the individual zones such as space temperature, gas levels, occupancy status, etc. Show the locations of individual pieces of monitored and controlled equipment.

c. For each equipment display show a 3-dimensional representation of the individual pieces of equipment using the symbols and M&C point data types as specified. Use different colors and textures to indicate various components and real time data. Use consistent color and texture meanings across all displays.

d. Provide displays which clearly distinguish between the following point data types and information:

   (1) Real-time data.
   (2) Other user-entered data.
   (3) Devices in alarm (unacknowledged).
   (4) Out-of-range, bad, or missing data.
   (5) Points which are overridden.

3. Navigation Commands - Provide system displays which support English language operator commands via touch screen entry for defining and selecting points, parameters, graphics, report generation, and all other functions associated with operation.

4. Graphic Editor - Provide a fully featured graphics editor and capable of creating custom graphics and graphic symbols for use by the System Display Editor.

5. System Display Editor - Provide a system display editor which allows the user to create, modify, and delete graphic displays. The display editor may have a separate user interface. Provide a display editor which includes the following functions:

a. Create and save displays. Save an existing or modified display as a new display (i.e. "save as")

b. Group and ungroup graphics, where graphics include both alpha-numeric and graphic symbols, and where a grouped graphic is manipulated as a single graphic.

c. Place, locate, resize, move, remove, reposition, rotate and mirror a graphic on a display.

d. Overlay graphics over other graphics and assign depths such that when there are coincident graphics the one on top is visible.

e. Modify graphic properties based on the value of network points and create conditions governing the display of a graphics such that different graphics are visible based on the value of network points or calculated points.

f. Integrate real-time data with the display.

g. Establish connecting lines.

h. Establish sources of latest data and location of readouts.

i. Display analog values as specified.

j. Assign conditions which automatically initiate a system display.

k. Include library of display symbols which include: Motor, Flow Sensing Element, Point and Averaging Temperature Sensors, Pressure Sensor, Gas Sensors, Humidity Sensor, Make-Up Air Handling Unit, Fan, Ductwork, Unit Heater, Damper, Limit Switch, Flow Switch, High- and Low- Point and Averaging Temperature Switches, High- and Low- Pressure Switches, Relay,
Filter, Current Sensing Relays, Circuit Breaker. Symbols must at a minimum conform to ASHRAE FUN IP where applicable.

6. Scheduling

   a. The M&C software must be capable of performing time synchronization and configuring Schedule Objects in ASHRAE 135 field devices in accordance with the DM-MTS-A (Device Management-Manual Time Synchronization-A).
   b. The M&C software must be capable of performing time synchronization and configuring Niagara Framework Schedule Objects in Niagara Framework Supervisory Gateways.
   c. The M&C Software must include a scheduling graphic display, accessible via the graphical user interface, with the following fields and functions:

       (1) Current date and time.
       (2) System identifier(s) and name(s), including location information such as Building name(s) and number(s).
       (3) Seasonal schedules. For each system, a seasonal schedule based on a specific calendar day schedule with independent schedules for each season including no less than 6 value changes.

7. Alarms - Provide M&C Software meeting the following minimum requirements for alarms:

   a. The M&C software must support at least two alarm priority levels: critical and informational. Critical alarms must route to the SCADA system and remain in alarm until acknowledged by the SCADA operator and the alarm condition no longer exists; informational alarms are only local to the MCS and must remain in alarm until the alarm condition no longer exists, or until the alarm is acknowledged.
   b. The creation, modification, and handling (routing) of alarms must be fully accessible and fully adjustable from the graphical user interface.
   c. Alarm Data. Alarm data to be displayed and stored must include:

       (1) Identification of alarm including building, system (or sub-system), and device name.
       (2) Date and time to the nearest second of occurrence.
       (3) Alarm type.
       (4) Current value or status of the alarm point, including engineering units.
       (5) Alarm limits, including engineering units.
       (6) Alarm priority.
       (7) Alarm Message: A unique message with a field of at least 60 characters. Assignment of messages to an alarm must be an operator editable function.
       (8) Acknowledgement status of the alarm including the time, date and user of acknowledgement.

   d. Alarm Notification and Routing: The M&C software must be capable of performing alarm notification and routing functions. Upon receipt of ASHRAE 135 event notification, the M&C software must immediately perform alarm notification and routing according to an assigned routing for that alarm. The M&C software must support at least 100 alarm routes, where an alarm route is a unique combination of any of the following activities:

   e. Alarm Display and Acknowledgement. The M&C software must include an alarm display. Alarms must be capable of being acknowledged from this display. Multiple alarms must be capable of being acknowledged using a single command. Operator acknowledgment of one alarm must not automatically be considered as acknowledgment of any other alarm nor may it inhibit reporting of subsequent alarms.
f. Alarm Storage and Reports: The M&C software must store each alarm and its associated alarm data to hard disk and retain this information after the alarm no longer exists. The stored data must be sortable and searchable.

8. Trending - Provide M&C software capable of creating, modifying, uploading and archiving ASHRAE 135 Trend Objects in field devices in accordance with the B-AWS BIBBs and of using the Niagara history service to create, modify, upload and archive trend log objects in Niagara Framework Supervisory Gateways.

   a. The M&C Software must include a graphical display for trend configuration, creation and deletion accessible through the graphical user interface. Each trend must be user-configurable for:

      (1) Sampling interval: adjustable between 1 second and 1 hour.
      (2) Start and Stop Time of Trend.

   b. The M&C software must be capable of displaying a graphical representation of each trend, and of multiple trended points on the same graph. The software must be capable of saving trend logs to a file. If the file format is not plain ASCII text in a Comma-Separated-Value (CSV) format, provide a means to export or convert the file to plain ASCII text in a CSV format.

2.5 UNINTERRUPTIBLE POWER SUPPLY (UPS)

Provide uninterruptible power supplies (UPS) as self-contained devices suitable for installation and operation at the location of the MCS cabinet and sized to provide a minimum of 20 minutes of operation of the connected hardware. Equipment connected to the UPS must not be affected in any manner by a power outage of a duration less than the rated capacity of the UPS. Provide the UPS complete with all necessary power supplies, transformers, batteries, and accessories. Provide UPS which include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of AC input loss and low battery power. Provide UL 1778 approved UPS. UPS powering Server Hardware must notify the server via USB interface of impending battery failure.

2.6 EXISTING EQUIPMENT

A. The MCS shall control all existing HVAC equipment in the electrical room. This includes the Unit Heater and associated thermostat, along with the exhaust fan, damper, and its associated thermostat.

B. The sequence of operations for existing equipment shall remain unchanged. Include HAND/OFF/AUTO switch and indicator lights for ventilation duct fan.

2.7 RACKS AND ENCLOSURES

A. Enclosures - Enclosures supplied as an integral (pre-packaged) part of another product are acceptable. Provide two Enclosure Keys for each lockable enclosure on a single ring per enclosure with a tag identifying the enclosure the keys operate. Provide enclosures meeting the following minimum requirements:

    1. Mechanical and Electrical Rooms - For enclosures located in mechanical or electrical rooms, provide enclosures meeting NEMA 250 Type 2 requirements.
PART 3 EXECUTION

3.1 EXISTING CONDITIONS SURVEY

Perform a field survey, including but not limited to testing and inspection of equipment to be part of the MCS, and submit an Existing Conditions Report documenting the current status and its impact on the Contractor's ability to meet this specification. For existing systems to be integrated to the MCS, verify all requirements for connection to the new MCS. This includes the existing HVAC equipment in the building that will remain and be controlled by the new MCS.

3.2 DRAWINGS AND CALCULATIONS

A. MCS Contractor Design Drawings - Revise and update the Contract Drawings to include details of the system design and all hardware components, including contractor provided and Owner furnished components. Details to be shown on the Design Drawing include:

a. The logical structure of the network, including but not limited to the location of all Control Hardware (including but not limited to each BACnet Supervisory Controller, Control Protocol Gateway, Control Protocol Router, Niagara Framework Supervisory Gateway and Monitoring and Control (M&C) Controller).

b. Manufacturer and model number for each piece of Computer Hardware and Control Hardware.

c. Physical location for each piece of Computer Hardware and Control Hardware.

d. Version and service pack number for all software and for all Control Hardware firmware.

B. As-Built Drawings - Prepare draft as-built drawings consisting of Points Schedule drawings for the entire MCS, including Points Schedules for each Gateway, and an updated Design Drawing including details of the actual installed system as it is at the conclusion of Start-Up and Start-Up Testing. Provide As-Built Drawings which include details of all hardware components, including contractor provided and Owner furnished components. In addition to the details shown in the design drawings, the as-built drawing must include:

a. IP address(es) and Ethernet MAC address(es) as applicable for each piece of Control Hardware (including but not limited to each BACnet Supervisory Controller, Niagara Framework Supervisory Gateway, Control Protocol Gateway, Control Protocol Router, and Monitoring and Control (M&C) Controller).

b. IP address and Ethernet MAC address for each computer server/workstation or networked device.

c. List of ports, protocols and network services for each device connected to the network.

d. Network Addresses: ASHRAE 135 address and Object_ID of the Device Object for all Control Hardware using ASHRAE 135. Niagara Framework Station ID for all Niagara Framework components including but not limited to Niagara Framework Supervisory Gateways and the Web Supervisor.

e. Prepare Draft As-Built Drawings upon the completion of Start-Up and Start-Up Testing and Final As-Built Drawings upon completion of PVT Phase II.

3.3 INSTALLATION REQUIREMENTS

A. General - Install system components as shown and specified and in accordance with the manufacturer's instructions and provide necessary interconnections, services, and adjustments required for a complete and operable system. Install communication equipment and cable
grounding as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. Install low control voltage wiring as specified in Section 26 05 19 “Control Voltage Electrical Power Cables” and 26 05 33” Raceways and Boxes for Electrical Systems”. Ensure the enclosure and equipment is rated for the environmental conditions where it will reside.

B. Isolation, Building Penetrations and Equipment Clearance

1. Provide dielectric isolation where dissimilar metals are used for connection and support. Make all penetrations through and mounting holes in the building exteriors watertight. Drill or core drill holes in concrete, brick, steel and wood walls with proper equipment. Seal conduits installed through openings with materials which are compatible with existing materials. Seal openings with materials which meet the requirements of NFPA 70 and SECTION 07 84 13 FIRESTOPPING.

C. Nameplates - Provide Nameplates for all Control Hardware and all Computer Hardware. Attach Nameplates to the device in a conspicuous location.

3.4 INSTALLATION OF EQUIPMENT

A. Wire and Cable Installation

1. Install system components and appurtenances in accordance with NFPA 70, manufacturer’s instructions and as indicated. Provide necessary interconnections, services, and adjustments required for a complete and operable signal distribution system. Label components in accordance with TIA-606. Mark wiring terminal blocks and outlets in accordance with TIA-606. Do not install control cables in the same raceway with power cables. Properly secure and install neat in appearance cables not installed in conduit or raceways.

B. Grounding - Install signal distribution system ground in accordance with TIA-607 and Section 26 05 26 “Grounding and Bonding for Electrical Systems”. Connect equipment racks to the electrical safety ground.

C. Power-Line Surge Protection - Protect equipment connected to ac circuits must be protected against or withstand power-line surges. Provide equipment protection which meets the requirements of IEEE C62.41. Do not use fuses for surge protection.

D. Computer Hardware and Software

1. Hardware Installation - Install Computer Hardware as specified and indicated. Power Computer Servers through a UPS, and install and configure them such that the server automatically undergoes a clean shutdown upon low battery signal from the UPS.

2. Software Installation

   a. Monitoring and Control Software: Install M&C Software on server hardware, Monitoring and Control (M&C) Controller Hardware, or appropriate devices for the system. Install M&C Software in a manner consistent with its B-AWS listing such that it provides all functionality of a B-AWS.

   b. Provide sufficient computer hardware and M&C Controller Hardware and install M&C Software to support the number of points required, regardless of the number of points integrated under this project specification.

   c. M&C Controller Hardware Configuration Software: Install the M&C Controller Hardware Configuration Software on server hardware.
3. Monitoring and Control (M&C) Software Configuration
   a. Set up M&C Software user accounts and passwords. Coordinate user accounts, passwords and permissions with the Owner.
   b. Change the default password on all accounts. Remove or disable any accounts which do not require authentication (such as guest accounts).

4. Control Hardware Installation - Install Control Hardware in a lockable enclosure and as specified. Configure Control Hardware as specified, as required to meet the functions for which the hardware is used and as follows:
   a. Disable all ports, protocols, and network services other than those required or specifically permitted by this Section.
   b. Change the default passwords in all Control Hardware which have passwords. Coordinate new passwords with the owner.

3.5 INTEGRATION OF FIELD CONTROL SYSTEMS

A. Fully integrate the field control systems in accordance with the following three step sequence and as specified and shown.

   STEP 1: Install and configure Control Hardware as necessary to connect the field control system to the FPOC, which is part of the MCS network, and to provide control protocol translation and supervisory functionality.

   STEP 2: Add Field Control System to M&C Software: Perform system discovery, system database merges, or any other actions necessary to allow M&C Software access to the field control system.

   STEP 3: Configure M&C Software to provide monitoring and control of the field control system, including but not limited to the creation of system displays and the configuration of scheduling, alarming, and trending.

B. Integration Step 1: Install Control Hardware

   1. Install Control Hardware as specified at the FPOC location to connect the field control system to the MCS network via the FPOC and, if necessary, to provide control protocol translation and supervisory functionality. Coordinate all connections and other activities related to the SCADA system with the owner. Depending on the field control system media and protocol, this must be accomplished through one of the following:

      a. Connect the existing equipment at the FPOC location to the FPOC.
      b. Install either a Control Protocol Gateway or Niagara Framework Supervisory Gateway connected to both the field control network and the FPOC.
      c. Install a Control Protocol Router connected to both the field control network and the FPOC.
      d. Install a Control Protocol Gateway connected to the field control network. Then install a Control Protocol Router connected to both the Control Protocol Gateway and the FPOC.
      e. In addition, for integration of field control systems via ASHRAE 135, also install a BACnet Supervisory Controller as needed to implement scheduling, alarming and trending in the field control system. The BACnet supervisory controller may be the same device as the control protocol gateway or router.

C. Integration Step 2: Add Field Control System to M&C Software
1. Perform system discovery, system database merges, or any other actions necessary to allow M&C Software access to points and data in the field control system.
2. Perform all actions necessary to make all points from the field control system available in the M&C Software.

D. Integration Step 3: Configure M&C Software

1. Configure M&C Software to provide monitoring and control of the field control system, including but not limited to the creation of system displays and the configuration of scheduling, alarming, and trending.
2. Configure M&C Software Communication - Create and configure points and establish network communication between M&C Software and Field Control Systems as specified to support M&C Software functionality:
   a. Update points on currently active displays via polling as necessary to meet M&C Software display refresh requirements.
   b. Send points used for overrides to the device receiving the override as shown on the Points Schedule. For BACnet systems write operator overrides with a priority of 8 and demand limiting overrides with a priority of 10.
   c. events from ASHRAE 135 field control systems used for alarms.

3. Configure M&C Software Functionality - Fully configure M&C Software functionality using the M&C Software capabilities specified in PART 2 of this Section.
   a. Create System Displays using the project site. Label all points on displays with full English language descriptions. Configure user permissions for access to and executions of action using graphic pages. Coordinate user permissions with the owner.
   b. Configure alarm handling as specified.
   c. Configure scheduling.
   d. Create and configure displays for configuration of Schedule Objects. Label schedules and scheduled points with full English-language descriptors. Provide a separate configuration capability for each schedule. A single configuration display may be used to configured multiple schedules, provided that each schedule is separately configurable from the display.
   e. Create and configure Trend Objects. Trend points at 15 minute intervals.
   f. Create and configure displays for creation and configuration of trends and for display of all trended points.

3.6 START-UP AND START-UP TESTING

A. Test all equipment and perform all other tests necessary to ensure the system is installed and functioning as specified. Prepare a Start-Up and Start-Up Testing Report documenting all tests performed and their results and certifying that the system meets the requirements specified in the contract documents.

3.7 PERFORMANCE VERIFICATION TEST (PVT)

A. PVT Phase I Procedures

1. Provide PVT Procedures which include:
   a. Test System Reaction during PVT: The total system response time from initiation of a control action command from the workstation, to display of the resulting status change on the
workstation must not exceed 20 seconds under system normal heavy load conditions assuming a zero response time for operation of the node's control device.

b. Verification of Network Connectivity.
c. Verification of configuration of M&C Software functionality.

B. PVT Phase I - Demonstrate compliance of the control system with the contract documents. Using test plans and procedures previously approved by the Owner, demonstrate all physical and functional requirements of the project. Upon completion of PVT Phase I and as specified, prepare and submit the PVT Phase I Report documenting all tests performed during the PVT and their results. In the PVT report, include all tests in the PVT Procedures and any other testing performed during the PVT. Document failures and repairs with test results.

C. PVT Phase II

1. Include Basic Training as part of PVT Phase II. Failures or deficiencies of the MCS during Basic Training are considered PVT failures. Upon completion of PVT Phase II, and as specified, prepare and submit the PVT Phase II Report documenting any failures which occurred and repairs performed during PVT Phase II.

3.8 MAINTENANCE AND SERVICE

A. Perform inspection, testing, cleaning, and part or component replacement as specified and as required to maintain the warranty. Work includes providing necessary preventive and unscheduled maintenance and repairs to keep the MCS operating as specified, and accepted by the Owner, and other services as specified. Perform work in compliance with manufacturer’s recommendations and industry standards. Provide technical support via telephone during regular working hours.

B. Work Coordination - Schedule and arrange work to cause the least interference with the normal Owner business and mission. In those cases where some interference may be essentially unavoidable, coordinate with the Owner to minimize the impact of the interference, inconvenience, equipment downtime, interrupted service and personnel discomfort.

C. Work Control - Upon completion of work on a system or piece of equipment, that system or piece of equipment must be free of missing components or defects which would prevent it from functioning as originally intended and designed. Replacements must conform to the same specifications as the original equipment. During and at completion of work, do not allow debris to spread unnecessarily into adjacent areas nor accumulate in the work area itself.

D. Equipment Repairs

1. Initiate and complete equipment repairs within the following time periods, where time periods are measured as actual elapsed time from first notification, including working and non-working hours:

   a. for non-redundant computer server hardware, initiate within 4 hours and complete within 8 hours.
   b. for active (powered) control hardware, initiate within 4 hours and complete within 6 hours.
   c. for cabling and other passive network hardware, initiate within 16 hours and complete within 5 days.

2. Repair is the restoration of a piece of equipment, a system, or a facility to such condition that it may be effectively used for its designated purposes. Repair may be overhaul, reprocessing, or replacement of nonfunctional parts or materials or replacement of the entire unit or system.
E. Replacement, Modernization, Renovation

1. The Owner may replace, renovate, or install new equipment as part of the MCS at Owner expense and by means not associated with this contract without voiding the system warranty. Replaced, improved, updated, modernized, or renovated systems and equipment interfaced to the system may be added to the Contractor’s maintenance and service effort as a modification.

F. Access To MCS Equipment

1. Access to MCS equipment must be in accordance with the following:
   a. Coordinate access to facilities and arrange that they be opened and closed during and after the accomplishment of the work effort. For access to a controlled facility contact the Owner for assistance.
   b. The Owner may provide passwords for access to MCS computer equipment where the Owner determines such issuance is appropriate. Establish and implement methods of ensuring that passwords issued by the Owner are not used by unauthorized persons.

G. Records, Logs, and Progress Reports

1. Keep records and logs of each task, and organize cumulative chronological records for each major component, and for the complete system. Maintain a continuous log for the MCS. Keep complete logs and be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the MCS.

H. Service Call Reception

1. A Owner representative will advise the Contractor by phone or in person of all maintenance and service requests, as well as the classification of each based on the definitions specified. A description of the problem or requested work, date and time notified, location, classification, and other appropriate information will be placed on a Service Call Work Authorization Form by the Owner.
2. Submit procedures for receiving and responding to service calls 24 hours per day, seven days a week, including weekends and holidays. Provide a single telephone number for receipt of service calls during regular working hours; service calls are to be considered received at the time and date the telephone call is placed by the authorized Owner representative.
3. Separately record each service call request, as received on the Service Call Work Authorization form and complete the Service Call Work Authorization form for each service call. Include the following information in the completed form: the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion.
4. Respond to each service call request within two working hours. Provide the status of any item of work within six hours of the inquiry during regular working hours, and within 16 hours after regular working hours or as needed to meet the Equipment Repair requirements as specified.

I. Service Call Work Warranty

1. Provide a 2 year unconditional warranty on service call work which includes labor and material necessary to restore the equipment involved in the initial service call to a fully operable condition. In the event that service call work causes damage to additional equipment, restore the system to full operation without cost to the Owner. Provide response times for service call warranty work equivalent to the response times required by the initial service call.
J. System Modifications

1. Make recommendations for system modification in writing to the Owner. Do not make system modifications without prior approval of the Owner. Incorporate any modifications made to the system into the Operations and Maintenance Instructions, and any other documentation affected. Make available to the Owner software updates for all software furnished under this specification during the life of this contract. Schedule at least one update near the end of the contract period, at which time make available the latest released version of all software provided under this specification, and install and validate it upon approval by the Owner.

3.9 TRAINING

A. Conduct training courses for designated personnel in the maintenance, service, and operation of the system as specified, including specified hardware and software. The training must be oriented to the specific system provided under this contract. Provide audiovisual equipment and other training material and supplies required for the training. When training is conducted at Owner facilities, the Owner reserves the right to record the training sessions for later use. A training day is defined as 8 hours of classroom instruction, excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For guidance in planning the required instruction, the Contractor should assume that attendees will be tradesmen such as electricians, engineers or system operators. Obtain approval of the training schedule from the Owner at least 30 days prior to the first day of training.

B. Training Documentation

1. Prepare and submit one set of Training manuals for each of Basic Training Documentation, Advanced Training Documentation, and Refresher Training Documentation, where each set of documentation consists of:
   2. Course Attendance List.
   3. Training Manuals - Include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson in the training manuals. Where portions of the course material are presented by audiovisuals, include copies of those audiovisuals as a part of the printed training manuals.

C. Basic Training

1. Conduct a Basic Training course at the project site on the installed system for a period of no less than 4 hours during Phase 2 of the PVT. A maximum of ten personnel will attend this course. Design training targeted towards training personnel in the day-to-day operation and basic maintenance of the system. Upon completion of this course, each student, using appropriate documentation, should be able to start the system, operate the system, recover the system after a failure, perform routine maintenance and describe the specific hardware architecture and operation of the system. Include the following topics at a minimum:
   a. General system architecture.
   b. Functional operation of the system, including workstations and system navigation.
   c. System start-up procedures.
   d. Failure recovery procedures.
   e. Schedule configuration.
   f. Trend configuration.
   g. Perform point overrides and override release.
   i. Alarm reporting and acknowledgements.
   j. Diagnostics.
k. Historical files.

l. Maintenance procedures:

   (1) Physical layout of each piece of hardware.
   (2) Troubleshooting and diagnostic procedures.
   (3) Preventive maintenance procedures and schedules.

D. Advanced Training

1. Conduct an Advanced Operator Training course at the project site for a period of not less than 6 hours. A maximum of five personnel will attend this course. Structure the course to consist of "hands-on" training under the constant monitoring of the instructor. Include training on the M&C Software, and the BACnet Network Browser, or the Niagara Framework Engineering Tool. Upon completion of this course, the students should be fully proficient in the operation and management of all system operations and must be able to perform all tasks required to integrate a field control system into the MCS. Report the skill level of each student at the end of this course. Include the following topics at a minimum:

   a. A review of all topics in Basic Training
   b. Using the BACnet Network Browser for network discovery.
   c. M&C Software configuration, including but not limited to: creating and editing system displays, alarms, schedules, trends, demand limiting and calculations.
APPENDIX A

<table>
<thead>
<tr>
<th>QC CHECKLIST</th>
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<tbody>
<tr>
<td>This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.</td>
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This checklist is for (check one):

<table>
<thead>
<tr>
<th>Pre-Construction QC Checklist Submittal (Items 1-2)</th>
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<tr>
<th>Post-Construction QC Checklist Submittal (Items 1-6)</th>
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<th>Close-out QC Checklist Submittal (Items 1-14)</th>
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Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.

Verify the following items for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:

1. Contractor Design Drawing Riser Diagram includes location and types of all Control Hardware and Computer Hardware. | [ ] |

2. M&C Software supports the Niagara Framework, and ASHRAE 135. M&C Software is BTL Listed as a B-AWS. | [ ] |

Verify the following items for Post-Construction and Closeout QC Checklist Submittal:

3. Communication between the M&C Software and Niagara Framework field control systems uses only Fox protocol. Communication between the M&C Software and ASHRAE 135 field control systems uses only ASHRAE 135. | [ ] |
<table>
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<tr>
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<th>QC CHECKLIST</th>
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<tr>
<td>4</td>
<td>Connections to field control systems are via Niagara Framework Supervisory</td>
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<td>Gateways.</td>
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<td>5</td>
<td>Computer workstations and servers are installed as shown on the MCS Riser</td>
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<tr>
<td></td>
<td>Diagram.</td>
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<tr>
<td>6</td>
<td>Training schedule and course attendee lists have been developed and</td>
</tr>
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<td></td>
<td>coordinated with shops and submitted.</td>
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<tr>
<td></td>
<td>Verify the following items for Closeout QC Checklists Submittal:</td>
</tr>
<tr>
<td>7</td>
<td>All points in field control systems have been discovered using the Niagara</td>
</tr>
<tr>
<td></td>
<td>Framework Engineering Tool and are available at the M&amp;C Software.</td>
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<tr>
<td>8</td>
<td>All software has been licensed to the Owner.</td>
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<tr>
<td>9</td>
<td>M&amp;C software monitoring displays have been created for all building systems,</td>
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<td></td>
<td>including all override and display points indicated on Points Schedule</td>
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<td>drawings.</td>
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<td>10</td>
<td>Final As-built Drawings accurately represent the final installed system.</td>
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<tr>
<td>11</td>
<td>Default trends have been set up (per Points Schedule drawings).</td>
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<tr>
<td>12</td>
<td>Scheduling has been configured at the M&amp;C Software (per Occupancy Schedule</td>
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<td>drawing).</td>
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## QC CHECKLIST

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<tr>
<td>13</td>
<td>O&amp;M Instructions have been completed and submitted.</td>
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<tr>
<td>14</td>
<td>Basic Operator and Advanced Training courses have been completed.</td>
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___________________________________________      __________________

(QC Representative Signature)                      (Date)

END OF SECTION 23 10 10
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipes, tubes, and fittings.
   2. Piping specialties.
   3. Piping and tubing joining materials.
   5. Dielectric unions.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
   1. Piping and Valves: 100 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: 0.25 psig.

C. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

2.2 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
   3. Protective Coating for Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

2.3 PIPING SPECIALTIES

A. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.


C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.5 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
   1. CWP Rating: 125 psig.
   3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
   4. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
5. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; Conbraco Industries, Inc.
   b. BrassCraft Manufacturing Co.; a Masco company.

3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; Conbraco Industries, Inc.
   b. BrassCraft Manufacturing Co.; a Masco company.

3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. A.Y. McDonald Mfg. Co.
   b. Apollo Valves; Conbraco Industries, Inc.
   c. BrassCraft Manufacturing Co.; a Masco company.

3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. A.Y. McDonald Mfg. Co.

5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

2.6 DIELECTRIC UNIONS

A. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. A.Y. McDonald Mfg. Co.
   b. Watts; a Watts Water Technologies company.
   c. Wilkins.

2. Description:
   b. Pressure Rating: 125 psig minimum at 180 deg F.
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

3.2 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
G. Locate valves for easy access.
H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
I. Install piping free of sags and bends.
J. Install fittings for changes in direction and branch connections.
K. Verify final equipment locations for roughing-in.
L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
   1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
N. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
O. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
P. Connect branch piping from top or side of horizontal piping.
Q. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment.

R. Do not use natural-gas piping as grounding electrode.

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 “Sleeves and Sleeve Seals for HVAC Piping”.

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 05 17 “Sleeves and Sleeve Seals for HVAC Piping”.

3.3 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.

3.4 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Welded Joints:

2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Section 23 05 29 “Hangers and Supports for HVAC Piping and Equipment”.

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

C. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.
D. For gas piping on roof, provide roof supports equal to Erico Caddy Pyramid ST, spaced 8’ oc or per manufacturer’s recommendation. Coordinate roof support installation with new roof installation.

3.6 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.7 LABELING AND IDENTIFYING

A. Comply with requirements in Section 23 05 53 “Identification for HVAC Piping and Equipment” for piping and valve identification.

3.8 FIELD QUALITY CONTROL

A. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.

B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 OUTDOOR PIPING SCHEDULE

A. Aboveground natural-gas piping shall be:

1. Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

B. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.10 INDOOR PIPING SCHEDULE

A. Aboveground, branch piping NPS 1 and smaller shall be the following:

1. Steel pipe with wrought-steel fittings and threaded joints. Coat pipe and fittings with protective coating for steel piping.
B. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

C. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints.

3.11 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, full-port, bronze ball valves with bronze trim.

B. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, regular-port, bronze ball valves with bronze trim.

C. Valves in branch piping for single appliance shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, regular-port, bronze ball valves with bronze trim.

END OF SECTION 23 11 23
SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary
   Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:
   1. Copper tube and fittings.
   2. Joining materials.
   3. Dielectric fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Pipe.
   2. Fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown
   and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Other building services.
   3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

E. Preconstruction Test Reports:

   1. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at
      Project site.
1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

   1. Hot-Water Heating Piping: 150 psig at 200 deg F.
   2. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. DWV Copper Tubing: ASTM B 306, Type DWV.

C. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Anvil International.
      b. Star Pipe Products.
      c. Victaulic

   2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.

   3. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.
D. Copper or Bronze Pressure-Seal Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elkhart Products Corporation.
      b. Mueller Industries, Inc.
      c. NIBCO INC.
   2. Housing: Copper.
   3. O-Rings and Pipe Stops: EPDM.
   4. Tools: Manufacturer's special tools.
   5. Minimum 200-psig working-pressure rating at 250 deg F.

E. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. T-Drill Industries.

F. Wrought-Copper Unions: ASME B16.22.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless otherwise indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. HART Industrial Unions, LLC.
   b. Watts; a Watts Water Technologies company.
   c. Wilkins.

2. Description:
   b. Pressure Rating: 150 psig minimum at 200 deg F.
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Watts; a Watts Water Technologies company.
   b. Wilkins.

2. Description:
   b. Factory-fabricated, bolted, companion-flange assembly.
   c. Pressure Rating: 150 psig minimum at 200 deg F.
   d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.

2. Description:
   a. Nonconducting materials for field assembly of companion flanges.
   b. Pressure Rating: 150 psig.
   c. Gasket: Neoprene or phenolic.
   d. Bolt Sleeves: Phenolic or polyethylene.
   e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Grinnell Mechanical Products.
   b. Precision Plumbing Products.

2. Description:
b. Electroplated steel nipple, complying with ASTM F 1545.
c. Pressure Rating: 300 psig at 225 deg F.
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be the following:
   1. Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves for servicing according to the following:
   1. Section 23 05 23 “Ball Valves for HVAC Piping”.

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Comply with requirements in Section 23 05 53 “Identification for HVAC Piping and Equipment” for identifying piping.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 “Sleeves and Sleeve Seals for HVAC Piping”.

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or flange kits.

3.4 HANGERS AND SUPPORTS

A. Comply with requirements in Section 23 05 29 “Hangers and Supports for HVAC Piping and Equipment” for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

D. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

I. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

3.7 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
   3. Isolate expansion tanks and determine that hydronic system is full of water.
   4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
   5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
   6. Prepare written report of testing.

C. Perform the following before operating the system:
   1. Open manual valves fully.
   2. Inspect pumps for proper rotation.
   3. Set makeup pressure-reducing valves for required system pressure.
   4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
   5. Set temperature controls so all coils are calling for full flow.
   6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
   7. Verify lubrication of motors and bearings.
END OF SECTION 23 21 13
Not to be used for bidding purposes
SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Single-wall rectangular ducts and fittings.
   2. Single-wall round ducts and fittings.
   4. Sealants and gaskets.
   5. Hangers and supports.

B. Related Sections:
   1. Section 23 05 93 “Testing, Adjusting, and Balancing for HVAC” for testing, adjusting, and balancing requirements for metal ducts.
   2. Section 23 33 00 “Air Duct Accessories” for sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
   3. Section 23 09 26 “Control Dampers” for dampers.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.

B. Shop Drawings:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Fittings.
4. Reinforcement and spacing.
5. Seam and joint construction.
6. Hangers and supports, including methods for duct and building attachment, and vibration isolation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Structural members to which duct will be attached.
3. Size and location of initial access modules for acoustical tile.

B. Welding certificates.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE


B. Welding Qualifications: Qualify procedures and personnel according to the following:


C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Ductmate Industries, Inc.
b. Linx Industries (formerly Lindab).
c. McGill AirFlow LLC.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ductmate Industries, Inc.
   b. Linx Industries (formerly Lindab).
   c. McGill AirFlow LLC.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
E. Tees and Laterals: Select types and fabricate according to SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Stainless Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, in wet well and screening rooms; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4.

D. Factory- or Shop-Applied Antimicrobial Coating:
   1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
   2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
   3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
   4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
   5. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Solvent-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
7. Mold and mildew resistant.
8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.
   2. Type: S.
   3. Grade: NS.
   5. Use: O.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers.


3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
3. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
4. Conditioned Space, Exhaust Ducts: Seal Class B.
5. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS
A. Make connections to equipment with flexible connectors complying with Section 23 33 00 “Air Duct Accessories”.

B. Comply with SMACNA’s “HVAC Duct Construction Standards - Metal and Flexible” for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING
A. Paint exterior of metal ducts that are visible to match existing in the space. Apply one coat of flat latex paint over a compatible galvanized-steel primer.

3.7 FIELD QUALITY CONTROL
A. Perform tests and inspections.

B. Leakage Tests:
2. Test the following systems:
   a. Exhaust Ducts: Test representative duct sections, totaling no less than 50 percent of total installed duct area for each designated pressure class.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:
1. Visually inspect duct system to ensure that no visible contaminants are present.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 START UP
A. Air Balance: Comply with requirements in Section 23 05 93 “Testing, Adjusting, and Balancing for HVAC”.

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3.9 DUCT SCHEDULE

A. Supply Ducts:

1. Ducts Connected to Supply Units, Air Handling Units, Heating Ventilating Units, and Terminal Units:
   a. Galvanized steel.
      1) Exposed to View: Painted to match existing duct in space.
   b. Pressure Class: Positive 2-inch wg.
   c. Minimum SMACNA Seal Class: C.
   d. SMACNA Leakage Class for Rectangular: 12.
   e. SMACNA Leakage Class for Round and Flat Oval: 12.

B. Return Ducts:

1. Ducts Connected to Supply Units, Air Handling Units, Heating Ventilating Units, and Terminal Units:
   a. Galvanized steel.
      1) Exposed to View: Painted to match existing duct in space.
   b. Pressure Class: Positive or negative 2-inch wg.
   c. Minimum SMACNA Seal Class: C.
   d. SMACNA Leakage Class for Rectangular: 12.
   e. SMACNA Leakage Class for Round and Flat Oval: 12.

C. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
   a. Galvanized steel.
      1) Exposed to View: Painted to match existing duct in space.
   b. Pressure Class: Negative 2-inch wg.
   c. Minimum SMACNA Seal Class: C if negative pressure, and A if positive pressure.
   d. SMACNA Leakage Class for Rectangular: 12.
   e. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Fans Exhausting from Wet Well/Screen Rooms (ASHRAE 62.1, Class 3 and 4) Air:
   a. Type 316, stainless-steel sheet.
      1) Exposed to View: No. 4 finish.
   b. PVC-coated, galvanized sheet steel with thicker coating on duct interior.
   c. Pressure Class: Positive or negative 3-inch wg.
   d. Minimum SMACNA Seal Class: A.
   e. SMACNA Leakage Class 3.
   f. Airtight/Watertight.
D. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Air Handling Units, Heating Ventilating Units, and Terminal Units:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: C.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

E. Intermediate Reinforcement:

2. PVC-Coated Ducts:
   a. Exposed to airstream: Match duct material.
   b. Not exposed to airstream: Match duct material.
3. Stainless-Steel Ducts:
   a. Exposed to airstream: Match duct material.
   b. Not exposed to airstream: Match duct material.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Velocity 1000 fpm or lower:
      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      2) Mitered Type RE 4 without vanes.
   b. Velocity 1000 to 1500 fpm:
      1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
   c. Velocity 1500 fpm or higher:
      1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vaness and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

      1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
      4) Radius-to Diameter Ratio: 1.5.

   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

   a. Velocity 1000 fpm or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm: Conical tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 13
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SECTION 23 31 16 - NONMETAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fiberglass Reinforced Plastic (FRP) ducts and fittings.

B. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

1. ASTM C 582 – Standard specification for contact – molded reinforced thermosetting plastic laminates for corrosion resistant equipment.
2. ASTM D 3982 – Standard specification for contact-molded fiberglass ducts and hoods.
5. SMACNA Thermoset FRP Duct Construction Manual
6. ASTM E 84 - Test for low flame

C. Related Requirements:

1. Section 23 05 48 VIBRATION CONTROLS FOR HVAC for vibration-isolated ductwork and hangers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Fiberglass Reinforced Plastic (FRP) duct materials.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale and coordinated with each other, using input from installers of the items involved.

B. Welding certificates.

C. Field quality-control reports.
1.4 QUALITY ASSURANCE

A. Hanger and Support Welding Qualifications: Qualify procedures and personnel according to the following:

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

1.5 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of ductwork that fail in materials or workmanship within a 2 year warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including duct closure, reinforcements, and hangers and supports, shall comply with the following and with the Works' performance requirements and design criteria:
   1. SMACNA's " Thermoset FRP Duct Construction Manual."
   2. Static-Pressure Classes:
      a. Supply Ducts (except in Mechanical Rooms): 2-inch wg.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions to comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1, Section 5.4 - "Airstream Surfaces."

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

F. NFPA Compliance:
   1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
   2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
2.2 FIBERGLASS REINFORCED PLASTIC (FRP) DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Beetle Plastics
2. Perry Fiberglass Products, Inc.

B. Fiber Glass Reinforced Polymer (FRP) duct material: polymer matrix with thermoplastic or thermoset resin, reinforced with glass fiber, corrosion resistant.

C. Service Conditions:

1. Ductwork shall be designed for exhausting Methane and Hydrogen Sulfide Gas. The minimum wall thickness for above grade FRP ductwork shall conform to the following:

   a. Surfacing veil shall be C glass veil with a silane finish and a soluble binder.
   b. Chopped strand mat shall be type ECR glass minimum 1.5 oz/sq ft (458 g/sq m) with silane finish and styrene soluble binder.
   c. Continuous roving for chopper gun spray up shall be type E glass.
   d. Woven roving shall be type E glass minimum 24 oz/sq yd (814 g/sq m)
   e. Continuous roving for filament winding shall be type E glass with silane finish.

2. Duct with inside area of 314 Sq In or less shall have a wall thickness of 0.125"; duct with inside area greater than 314 Sq In or less than 1000 Sq In shall have a wall thickness of 0.1875"; duct with inside area of 1000 Sq In or greater shall have a wall thickness of 0.25".

   a. Surfacing veil shall be C glass veil with a silane finish and a soluble binder.
   b. Chopped strand mat shall be type ECR glass minimum 1.5 oz/sq ft (458 g/sq m) with silane finish and styrene soluble binder.
   c. Continuous roving for chopper gun spray up shall be type E glass.
   d. Woven roving shall be type E glass minimum 24 oz/sq yd (814 g/sq m)
   e. Continuous roving for filament winding shall be type E glass with silane finish.

3. Minimum Hanger Spacing will be in accordance with ASTM D 3982, Table 1.

D. Construction:

1. FRP shall be of filament wound construction with a corrosion barrier. Cast duct with no reinforced internal corrosion barrier or press molded fittings will not be accepted.
2. FRP duct shall be factory assembled to the greatest possible extent, with a minimum number of field joints.
3. Maximum allowable deflection for any size ductwork shall be 0.50" (12.7mm) between supports and for any size of duct under worst case operating conditions.
4. FRP ductwork shall be designed using a safety factor of 10 to 1 for pressure and 5 to 1 for vacuum without exception.
5. Length of flanged duct sections shall not vary more than 0.50" (12.7mm) at 70 degrees F (21 degrees C).
6. Un-flanged duct sections shall be square on the ends in relation to the center axis within 0.125" (3.2mm) up to and including 24" (610mm) diameter and within 0.1875" (4.8mm) for all diameters greater than 24" (610mm).

E. Laminates:

1. Resin shall be a premium grade of fire retardant vinyl ester with a flame spread rating of less than 25, I.D. "Class 1" of ASTM E84 “Standard Method of Test for Surface Burning Characteristics of Building Material”. Resin shall be AOC’s #K022, Ashland’s #FR992 or Reichhold #9300.
2. Ductwork shall have a resin rich inner surface, an interior layer, a structural layer and an exterior layer with UV resistant coating.
3. Inner surface: Nominal 10 mils thick composed of a single ply of the “C glass surfacing veil, having a resin content of 90%.
4. Interior layer: Nominal 90 mils thick composed of at least two layers of 1-1/2" chopped strand mat. Resin content shall be 75%.
5. Structural layer: Filament wound type E glass to meet minimum wall thickness as specified. The total wall thickness includes the inner surface.
6. Exterior UV resistant coating: Factory applied corrosion resistant gel coat with UV inhibitors. Light gray shall be used as the standard color.

F. Fittings:
1. Fittings shall be hand lay-up construction fabricated from the same resin and have the same strength as the FRP duct.
2. The internal diameter of fittings shall be equal to the adjacent duct.
3. The centerline radius of all elbows shall be 1.5 times the diameter.
4. Elbows 24" (610mm) diameter and smaller shall be smooth radius. Elbows larger than 24" (610mm) diameter shall be mitered.
5. Elbows 45 degrees or less shall be at least two (2) miter/three (3) gore. Elbows greater than 45 degrees shall be at least four (4) miter/five (5) gore.

G. Flanges:
1. Provide flanged connections as required to flexible connectors, expansion joints, vessels, demisters, fans, silencers and other locations as shown.
2. Flanges shall be hand lay-up construction. Dimensions shall be in accordance with PS 15-69 – Table 2 and the duct dimension schedule.
3. Flange faces shall be perpendicular to the axis of the duct within 0.5 degree.
4. Flange faces shall be flat to within 0.0313" (0.8mm) up to and including 18" (457mm) diameter and within 0.0625" (1.6mm) for 20" (508mm) diameter and larger.
5. Gaskets shall be EPDM, full face and minimum 0.125" (3.2mm) thickness.
6. Bolts, nuts and washers shall be Type 316 stainless steel.

H. Joints:
1. Provide butt and wrap joints in accordance with ASTM D 3982.
2. Field weld materials shall be supplied by the duct manufacturer. Complete written and online video instructions shall be provided along with Material Safety Data Sheets.
3. Resin, catalyst and fiberglass materials shall be supplied in bulk for the total number of joints plus 20% extra.

I. Fabrication:
1. Comply with: SMACNA Thermoset FRP Duct Construction Manual for the following:
   a. Joints, seams, transitions, elbows, and branch connections.
   b. Reinforcements, including channel and tie rod reinforcement materials, spacing, and fabrications.
2. Fabricate 90-degree mitered elbows to include turning vanes.

J. Reinforcements: Comply with requirements in SMACNA’s Thermoset FRP Duct Construction Manual for channel- and tie-rod reinforcement materials, spacing, and fabrication.

2.3 HANGERS AND SUPPORTS

A. Hanger Rods: Type 316 Stainless Steel.
B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables: Type 316 stainless-steel cables with end connections made of stainless-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

D. Duct Attachments: Type 316 Stainless Steel Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports: Type 316 Stainless Steel shapes complying with ASTM A36/A36M.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install duct sections in maximum practical lengths with fewest possible joints.

C. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

D. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

E. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

F. Install ducts with a minimum clearance of 1 inch, plus allowance for insulation thickness.

G. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

H. Where ducts pass through non-fire-rated interior partitions and exterior walls, and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges. Overlap openings on four sides by at least 1-1/2 inches.

I. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

J. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.

K. Elbows: Use long-radius elbows wherever they fit.
1. Fabricate 90-degree rectangular mitered elbows to include turning vanes, and 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

L. Branch Connections: Use lateral or conical branch connections.

M. Install fibrous-glass ducts and fittings to comply with SMACNA's "Fibrous Glass Duct Construction Standards."

N. Install phenolic-foam ducts and fittings to comply with SMACNA's "Phenolic Duct Construction Standards."

O. Air Balance: Comply with requirements in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

3.2 HANGER AND SUPPORT INSTALLATION

A. Install hangers and supports for fibrous-glass ducts and fittings to comply with SMACNA's "Fibrous Glass Duct Construction Standards," Ch. 6, "Hangers and Supports."

B. Install hangers and supports for phenolic-foam ducts and fittings to comply with SMACNA's "Phenolic Duct Construction Standards" Ch. 6, "Hangers and Supports" and with manufacturer's written instructions.

C. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Leakage Tests:

2. Where static pressure and leakage values shown below differ from those in the SMACNA manual, the more stringent values shall apply.
3. Test the following systems:
   a. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
   b. Exhaust Ducts with a Pressure Class of 1-Inch wg or Higher: Test representative duct sections, totaling no less than 50 percent of total installed duct area for each designated pressure class.

4. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days’ advance notice for testing.

E. Duct System Cleanliness Tests:
   1. Test protocols shall be performed according to NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems," “Section 5 - Cleanliness Verification and Documentation.”
   2. Visually inspect duct system to ensure that no visible contaminants are present.
   3. Test sections of fibrous-glass duct system chosen randomly by Owner for cleanliness according to "Method 2 Protocol."
   4. Test sections of Phenolic-foam duct systems chosen randomly by Owner, for cleanliness according to "Method 3 - NADCA Vacuum Test."
      a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

F. Duct system will be considered defective if it does not pass tests and inspections.
G. Prepare test and inspection reports.

3.4 DUCT CLEANING
A. Clean duct system(s) before testing, adjusting, and balancing.
B. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch duct as recommended by duct manufacturer. Comply with Section 23 33 00 AIR DUCT ACCESSORIES for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling to gain access during the cleaning process.
C. Particulate Collection and Odor Control:
   1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. All duct cleaning shall be performed according to NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of ducts or duct accessories.
4. Clean fibrous-glass duct with HEPA vacuuming equipment; do not permit duct to get wet. Replace fibrous-glass duct that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for washdown procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removing surface deposits and debris.

3.5 DUCT SCHEDULE

A. Indoor Ducts and Fittings:

1. Fiber-Glass Reinforced Plastic Ducts and Fittings:
   a. Any new ductwork located on the wet well/screen room/hazardous side of the building shall be FRP.

B. Outdoor Ducts and Fittings:

1. Fiber-Glass Reinforced Plastic Ducts and Fittings
   a. Joints: Secure joints with adhesive or clips according to duct manufacturer's written instructions, then tape joints with aluminum vapor tape.
b. Sealing: All joints shall be sealed with a generous and continuous bead of silicone sealant and pressed into corners using a smooth radius tool.

END OF SECTION 23 31 16
SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Flange Connectors.
   3. Turning vanes.
   4. Duct-mounted access doors.
   5. Flexible connectors.
   6. Duct accessory hardware.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems,"

B. Comply with SMACNA’s "Thermoset FRP Duct Construction Manual" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Fiber Glass Reinforced Polymer (FRP) duct material: polymer matrix with thermoplastic or thermoset resin, reinforced with glass fiber, corrosion resistant.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 316, and having a No. 2B finish (only where FRP accessories are not available).

C. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
   2. Exposed-Surface Finish: Mill phosphatized.
2.3 **FLANGE CONNECTORS**

A. See Section 23 31 16 NONMETAL DUCTS.

2.4 **MANUAL VOLUME DAMPERS**

A. Standard, Stainless Steel, Manual Volume Dampers:

1. Standard leakage rating.
2. Suitable for horizontal or vertical applications.
3. Frames:
   a. Frame: Hat-shaped, 0.05-inch-thick stainless steel.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Stainless-steel, 0.064 inch thick.
6. Bearings:
   a. Stainless-steel sleeve.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
7. Tie Bars and Brackets: Stainless steel.

B. Jackshaft:

2. Material: Stainless-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

2. Include center hole to suit damper operating-rod size.

D. Include elevated platform for insulated duct mounting.

2.5 **TURNING VANES**

A. Manufactured Turning Vanes for Metal Ducts: Curved blades of stainless sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: Single wall.

2.6 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aire Technologies.
   2. Cesco Products; a division of MESTEK, Inc.
   3. Ductmate Industries, Inc.
   4. Elgen Manufacturing.
   5. Nailor Industries Inc.


   1. Door:
      a. Double wall, rectangular.
      b. Stainless sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
      d. Fabricate doors airtight and suitable for duct pressure class.

   2. Frame: Stainless sheet steel, with bend-over tabs and foam gaskets.

   3. Number of Hinges and Locks:
      a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
      b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
      c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
      d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.7 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. CL WARD & Family Inc.
   2. Ductmate Industries, Inc.
   3. Duro Dyne Inc.
   4. Elgen Manufacturing.
B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, stainless sheet steel. Provide metal compatible with connected ducts.

   1. Minimum Weight: 26 oz./sq. yd..
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.

2.8 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: FRP or Stainless Steel to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA’s "Thermoset FRP Duct Construction Manual" for FRP ducts.

B. Install duct accessories of materials suited to duct materials; use FRP or stainless-steel accessories in FRP ducts, and stainless-steel accessories in stainless-steel ducts.

C. Install test holes at fan inlets and outlets and elsewhere as indicated.

D. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. At outdoor-air intakes and motorized dampers.
   2. At drain pans and seals.
   3. At each change in direction and at maximum 50-foot spacing.
   4. Upstream and downstream from turning vanes.
   5. Upstream or downstream from duct silencers.
   6. Control devices requiring inspection.
   7. Elsewhere as indicated.

E. Install access doors with swing against duct static pressure.

F. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.

G. Label access doors according to Section 23 05 53 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT to indicate the purpose of access door.

H. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify operation.
3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00
SECTION 23 34 13 - AXIAL HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Mixed flow inline fans.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include rated capacities, furnished specialties, and accessories for each fan.
   2. Certified fan performance curves with system operating conditions indicated.
   3. Certified fan sound-power ratings.
   4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   5. Material thickness and finishes, including color charts.
   6. Dampers, including housings, linkages, and operators.
B. Shop Drawings:
   1. Include plans, elevations, sections, and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For axial fans to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
C. Performance ratings: Conform to ANSI/AMCA Standards 210 and 300. Fans must be tested in accordance with AMCA Publications 211 and 311 in an AMCA accredited laboratory and certified for air and sound performance. Fans shall be licensed to bear the AMCA ratings seal for air performance (AMCA 210) and sound performance (AMCA 300).

D. Classification for Spark Resistant Construction shall conform to ANSI/AMCA Standard 99.

E. Each fan shall be given an electronic vibration analysis in accordance with ANSI/AMCA Standard 204, while operating at the specified fan RPM. The vibration signatures shall be taken on each bearing in the horizontal, vertical and axial direction. The maximum allowable fan vibration shall be 0.15 in. /sec peak velocity, filter-in reading as measured at the fan RPM. This report shall be provided at no charge to the customer upon request.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.

B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer’s instructions. For long term storage follow manufacturer’s Installation, Operations, and Maintenance Manual.

C. Handling: Handle and lift fans in accordance with the manufacturer’s instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

1.7 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of supply units that fail in materials or workmanship within a 2 year warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AMCA Compliance:

1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
2. Operating Limits: Classify according to AMCA 99.

B. Service Conditions:

1. Ambient Temperature: 40 to 120 deg F.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2.2 MIXED-FLOW FANS (S-1)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Loren Cook.

B. Description: Fan wheel and housing, factory-mounted motor, discharge shutter, and accessories.
   1. Base fan performance at standard conditions (density 0.075 Lb./ft³).
   2. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
   3. Each fan shall be belt drive in AMCA arrangement 9.
   4. Fans are to be equipped with lifting lugs.
   5. After fabrication all carbon steel components shall be cleaned and chemically treated by a phosphatizing process to insure proper removal of grease, oil, scale, etc. Fan shall then be coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be RAL 7023, concrete grey. Coating must exceed 1,000-hour salt spray under ASTM B117 test method.

C. Fan and Housing Outlet:
   1. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
   2. Tubular fan housing shall be completely welded and coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be RAL 7023, concrete grey. No uncoated metal fan parts will be allowed.
   3. Housing and bearing support shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings.
   4. All mixed flow housings shall include welded steel vanes to straighten airflow prior to exiting the fan discharge.
   5. Units up to size 27 shall incorporate a universal mounting system that allows the fan to be mounted in either vertical or horizontal configurations and field rotation of the motor position in 90 degree increments. Bearing life shall not be reduced below specified level in different configurations. Units size 30 and larger shall allow for field rotation of motor positions. Units shall accommodate base mount or ceiling hung mounting without structural modifications to the fan.
   6. An access door shall be supplied for impeller inspection and service.
   7. OSHA compliant belt guard or motor cover to be included to completely cover the motor pulley and belt(s).

D. Fan Impeller:
   1. Fan impeller shall be mixed flow design. The impeller shall be electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19.
   2. Fan impeller shall be manufactured with continuously welded steel airfoils and coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be RAL 7023, concrete grey.
   3. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

E. Fan Motors and Drive:
1. Motors shall meet or exceed EPACT (Energy Policy ACT) efficiencies. Motors to be VFD rated, NEMA T-frame, 1800 or 3600 RPM, Open Drip Proof (ODP) with a 1.15 service factor.
2. Drive belts and sheaves shall be sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service, if required.
3. Fan shaft to be turned and polished steel that is sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class.
4. Fan shaft bearings shall be Air Handling Quality, bearings shall be heavy-duty grease lubricated, self-aligning or roller pillow block type.
5. Air Handling Quality bearings to be designed with low swivel torque to allow the outer race of the bearing to pivot or swivel within the cast pillow block. Bearings shall be 100% tested for noise and vibration by the manufacturer. Bearings shall be 100% tested to insure the inner race diameter is within tolerance to prevent vibration.
6. Bearings shall be selected for a basic rating fatigue life (L-10) of 120,000 hours at maximum operating speed for each pressure class (Average Life or (L-50) of 400,000 hours).
7. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be allowed.
8. Bearings shall have extended lube lines with Zerk fittings to allow for lubrication.

F. Accessories:
1. VFD rated Motor with Class B or greater insulation.
2. Universal mounting support.
3. Hanging, isolator spring, 1 inch.
4. Access door.
5. Inlet and outlet flanges, slip fit.
6. Extended lube lines.
7. Belt guard.
8. Mounting rails.

G. Factory Finishes:
1. Sheet Metal Parts: Prime coat before final assembly.

H. Capacities and Characteristics:
1. See equipment schedule on drawings.

2.3 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install fans level and plumb.
B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
C. Lift and support units with manufacturer's designated lifting or supporting points.
D. Equipment Mounting:
   1. Install fans per manufacturer's instructions
E. Install units with clearances for service and maintenance.
F. Label fans according to requirements specified in Section 23 05 53 “Identification for HVAC Piping and Equipment”.

3.3 CONNECTIONS

A. Ground equipment according to Section 26 05 26 “Grounding and Bonding for Electrical Systems”.
B. Connect wiring according to Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables”.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that mounting and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Adjust damper linkages for proper damper operation.
   5. Verify lubrication for bearings and other moving parts.
   6. Verify that volume control dampers are in fully open position.
7. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
8. Shut unit down and reconnect automatic temperature-control operators.
9. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING
A. Adjust damper linkages for proper damper operation.
B. Lubricate bearings.

3.6 CLEANING
A. Clean as recommended by manufacturer. Do not use material or methods which may damage finish surface or surrounding construction.

3.7 DEMONSTRATION
A. Train Owner's maintenance personnel to adjust, operate, and maintain fans.

END OF SECTION 23 34 13
SECTION 23 34 23 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Power roof exhausters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

4. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.

B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer’s instructions. For long term storage follow manufacturer’s Installation, Operations, and Maintenance Manual.
C. Handling: Handle and lift fans in accordance with the manufacturer’s instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

1.6 WARRANTY
A. Warranty: Manufacturer agrees to repair or replace components of exhauster units that fail in materials or workmanship within a 2 year warranty period.

PART 2 - PRODUCTS

2.1 DIRECT Driven POWER ROOF EXHAUST (REF-2 / REF-3)
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Loren Cook Company.
3. PennBarry.

B. General Description:
1. Downblast fan shall be for roof mounted applications.
2. Maximum continuous operating temperature is 180 Fahrenheit.
3. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number.

C. Housing:
1. Motor cover, shroud, curb cap, and lower windband shall be constructed of heavy gauge aluminum.
2. Shroud shall have an integral rolled bead for extra strength.
3. Shroud shall be drawn from a disc and direct air downward.
4. Lower windband shall have a formed edge for added strength.
5. Motor cover shall be drawn from a disc.
6. All housing components shall have final thicknesses equal to or greater than preformed thickness.
7. Curb cap shall have pre-punched mounting holes to ensure correct attachment.
8. Rigid internal support structure.
9. Leak proof.

D. Housing Supports and Drive Frame:
1. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.

E. Fan Wheels:
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05.
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.
F. Motor:
   1. Electronically Commutated Motor
      b. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
      c. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
      d. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
      e. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
      f. Motor shall be a minimum of 85% efficient at all speeds.

G. Vibration Isolation:
   1. Rubber isolators.
   2. Sized to match the weight of each fan.

H. Disconnect Switches:
   1. NEMA rated: 1
   2. Positive electrical shut-off.
   3. Wired from fan motor to junction box installed within motor compartment.

I. Accessories:
   1. Birdscreen:
      a. Material Type: Aluminum.
      b. Protects fan discharge.

J. Roof Curb Adapter:
   1. New curb adapter to be sized to existing roof curb, verify size in field.
   2. Mounted onto existing roof curb.
   4. Insulation thickness: 1 inch.
   5. Height: 12 inches.

K. Curb Seal:
   1. Rubber seal between the fan and the roof curb adapter.

L. Damper:
   1. Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
   2. Type: Gravity.
   3. Prevents outside air from entering back into the building when fan is off.
   4. Balanced for minimal resistance to flow.
M. Capacities and Characteristics:

1. See equipment schedule on drawings.

2.2 BELT DRIVEN POWER ROOF EXHAUST (REF-4)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Loren Cook Company.
3. PennBarry.

B. General Description:

1. Downblast fan shall be for roof mounted applications.
2. Maximum continuous operating temperature is 180 Fahrenheit.
3. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number.

C. Housing:

1. Motor cover, shroud, curb cap, and lower windband shall be constructed of heavy gauge aluminum.
2. Shroud shall have an integral rolled bead for extra strength.
3. Shroud shall be drawn from a disc and direct air downward.
4. Lower windband shall have a formed edge for added strength.
5. Motor cover shall be drawn from a disc.
6. All housing components shall have final thicknesses equal to or greater than preformed thickness.
7. Curb cap shall have pre-punched mounting holes to ensure correct attachment.
8. Rigid internal support structure.
9. Leak proof.

D. Housing Supports and Drive Frame:

1. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.

E. Fan Wheels:

3. Statically and dynamically balanced in accordance to AMCA Standard 204-05.
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.

F. Motor:

1. Motor enclosures: Open driproof.
2. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase.
3. Mounted on vibration isolators, out of the airstream.
4. For motor cooling there shall be fresh air drawn into the motor compartment through an area free of discharge contaminants.
5. Accessible for maintenance.
G. Shafts and Bearings:
   1. Fan shaft shall be ground and polished solid steel with an anti corrosive coating
   2. Permanently sealed bearings or pillow block ball bearings.
   3. Bearing shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
   4. Bearings are 100 percent factory tested.
   5. Fan Shaft first critical speed is at least 25 percent over maximum operating speed.

H. Drive Assembly
   1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
   2. Belts: Static free and oil resistant.
   3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
   4. The motor pulley shall be adjustable for final system balancing.
   5. Readily accessible for maintenance.

I. Vibration Isolation:
   1. Double studded or pedestal mount true isolators.
   2. No metal to metal contact.
   3. Sized to match the weight of each fan.

J. Disconnect Switches:
   1. NEMA rated: 1
   2. Positive electrical shut-off.
   3. Wired from fan motor to junction box installed within motor compartment.

K. Accessories:
   1. Auto Belt Tensioner:
      a. Automatic tensioning device that adjusts for the correct belt tension, only for single drives.
   2. Birdscreen:
      a. Material Type: Aluminum.
      b. Protects fan discharge.

L. Roof Curb Adapter:
   1. New curb adapter to be sized to existing roof curb, verify size in field.
   2. Mounted onto existing roof curb.
   4. Insulation thickness: 1 inch.
   5. Height: 12 inches.

M. Curb Seal:
   1. Foam seal between the fan and the roof curb adapter.

N. Damper:
1. Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
2. Type: Motorized.
3. Prevents outside air from entering back into the building when fan is off.
4. Balanced for minimal resistance to flow.
5. Galvanized frames with prepunched mounting holes.

O. Variable Frequency Drive

1. Factory programmed, mounted and wired.
2. Input speed control 0-10VDC.
3. 24VDC damper power output.
4. 24VDC control power output.
5. Motor: (VFD Rated) compatible with induction and permanent magnet motors.
6. Parameters of acquainted motor shall be set to include voltage, speed, FLA, acceleration/deceleration time, and minimum & maximum motor frequency.
7. R³ Filtering for harmonic mitigation.
8. UL Recognized for 3 phase input at 480V.
9. NEMA 4X Enclosure.
10. LED indication for Power, Run, and Fault.

P. Capacities and Characteristics:

1. See equipment schedule on drawings.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for the environment.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Ensure roof openings are square, accurately aligned, correctly located, and in tolerance.

B. Ensure duct is plumb, sized correctly, and to proper elevation above roof deck.

3.3 PROTECTION

A. Protect installed product and finished surfaces from damage during construction.
B. Protect installed exhaust fans to ensure that, except for normal weathering, fans will be without damage or deterioration at time of substantial completion.

3.4 INSTALLATION

A. Equipment Mounting:

1. Support suspended units from structure using threaded steel rods and spring hangers with vertical-limit stops having a static deflection of 1 inch. Vibration-control devices are specified in Section 23 05 48 “Vibration Controls for HVAC”.

B. Install units with clearances for service and maintenance.

C. Label units according to requirements specified in Section 23 05 53 “Identification for HVAC Piping and Equipment”.

D. Comply with manufacturer's product data, including technical bulletins, product catalog installation instructions.

E. Install fans system as indicated on the Installation, Operation and Maintenance Manual (IOM), contract drawings, and manufacturer's instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 26 05 26 “Grounding and Bonding for Electrical Systems”.

D. Connect wiring according to Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables”.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.7 ADJUSTING
A. Adjust exhaust fans to function properly.
B. Adjust damper linkages for proper damper operation.
C. Adjust belt tension.
D. Comply with requirements in Section 23 05 93 “testing, Adjusting, and Balancing for HVAC” for testing, adjusting, and balancing procedures.
E. Replace fan and motor pulleys as required to achieve design airflow.
F. Adjust drive for final system balancing.
G. Lubricate bearings.
H. Check wheel overlap.

3.8 CLEANING
A. Clean as recommended by manufacturer. Do not use material or methods which may damage finish surface or surrounding construction.

3.9 DEMONSTRATION
A. Train Owner's maintenance personnel to adjust, operate, and maintain fans.

END OF SECTION 23 34 23
SECTION 23 37 13 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Double deflection registers.
2. Single deflection registers.

B. Related Requirements:

1. Section 23 33 00 “Air Duct Accessories” for fire and smoke dampers and volume-control dampers not integral to registers and grilles.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 REGISTERS

A. Double Deflection Face Supply Register (SR):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Titus
   b. Carnes
   c. Krueger
3. Finish: Baked enamel, color selected by Owner.
8. Mounting Frame: For mounting to FRP ductwork or metal ductwork as shown on drawings, provide boot as required.
10. Damper Type: 304 stainless steel, adjustable opposed blade.
11. Titus model 300RL-SS or equal.

B. Single Deflection Face Exhaust Register (ER):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Titus
b. Carnes
  c. Krueger

3. Finish: Baked enamel, color selected by Owner.
5. Face Arrangement: Blade.
8. Mounting Frame: For mounting to FRP ductwork, provide boot as required.
10. Damper Type: 304 stainless steel, adjustable opposed blade.
11. Titus model 350RL-SS or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13
SECTION 23 37 23 – HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Hooded Relief Ventilators.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: For gravity ventilators.
   1. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
   2. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

1.3 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Roof-framing plans and other details, drawn to scale, and coordinated with each other, based on input from installers of the items involved.

1.4 CLOSEOUT SUBMITTALS
A. Include operation and maintenance data in operation and maintenance manuals.

1.5 QUALITY ASSURANCE
A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.6 DELIVERY, STORAGE, AND HANDLING
A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation
B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer’s instructions. For long term storage follow manufacturer’s Installation, Operations, and Maintenance Manual
C. Handling: Handle and lift fans in accordance with the manufacturer’s instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

1.7 COORDINATION
   A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY
   A. Manufacturer’s Warranty: Submit, for Owner’s acceptance, manufacturer’s standard warranty document executed by authorized company official. Manufacturer’s warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.

   The warranty of this equipment is to be free from defects in material and workmanship for a period of two years from the purchase date. Any units or parts which prove defective during the warranty period will be replaced at the Manufacturers option when returned to Manufacturer, transportation prepaid.

PART 2 - PRODUCTS

2.1 GENERAL DESCRIPTION
   A. Ventilator is low silhouette for relief applications with natural gravity or negative pressure system
   B. Selection based on non-ducted applications
   C. Relief units with throat widths through 48 inches are ship assembled when throat lengths do not exceed 96 inches
   D. Each fan shall bear a permanently affixed manufacture’s nameplate containing the model number and individual serial number.

2.2 PERFORMANCE REQUIREMENTS
   A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.
   B. ASHRAE 62.1 Compliance: Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-up."
   C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.
   D. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.
   E. Capacities and Characteristics:
1. See Equipment Schedule on Project Drawings.

2.3 FABRICATION

A. Factory fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.4 HOODED RELIEF VENTILATORS

A. Description: Hooded rectangular for relief air.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Carnes Company
   2. Greenheck Fan Corporation
   3. Loren Cook Company
   4. PennBarry
   5. Ruskin Company

C. Construction:

   1. Material: Galvanized steel, of thickness required to comply with structural performance requirements, but not less than 0.064-inch-thick base and 0.040-inch-thick hood; suitably reinforced.
   2. Hood Constructed of precision formed, arched panels with interlocking seams
   3. Vertical end panels are fully locked into hood end panels
   4. Base height is standard of 5 inches
   5. Curb cap is six inches larger then throat size
   6. Curb cap has pre-punched mounting holes for installation

D. Bird Screening:

   1. Constructed of ½ inch Galvanized mesh
   2. Mounted horizontally across the intake area of the hood

E. Dampers:

   1. Type: Automatic
   2. Prevents outside air from entering back into the building when fan is off
   3. Balanced for minimal resistance to flow
4. Galvanized frames with prepunched mounting holes

F. Roof Curbs:
   1. Type: GPI; Welded, straight sided curb with 2 inches of flashing flange and wood nailer
   2. Mounted onto roof with fan
   3. Material: Galvanized
   4. Insulation thickness: 1 inch
   5. Overall Height: 18 inches

G. Filters:
   1. Mounted in open end racks for easy removal
   2. Washable 2 inch aluminum mesh designed to remove contaminants from the air

2.5 MATERIALS

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming or otherwise recommended by metal producer for required finish.

C. Galvanized-Steel Sheet: ASTM A653/A653M, G90 zinc coating, mill phosphatized.

D. Stainless-Steel Sheet: ASTM A666, Type 304, with No. 4 or 6 finish.

E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
   1. Use types and sizes to suit unit installation conditions.
   2. Use screws for exposed fasteners unless otherwise indicated.

F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Secure gravity ventilators to roof curbs with zinc-plated hardware. Use concealed anchorages where possible. Refer to Section 07 72 00 "Roof Accessories."

C. Install gravity ventilators with clearances for service and maintenance.
D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during installation.

F. Label gravity ventilators according to requirements specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes, so no evidence remains of corrective work. Return items that cannot be refinshed in the field to the factory, make required alterations, and refinish entire unit or provide new units.

I. Refer to Section 07 72 00 "Roof Accessories" for flashing and counterflashing of roof curbs.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in Section 23 31 13 "Metal Ducts". Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

A. Adjust ventilator to function properly

3.4 CLEANING

A. Clean as recommended by manufacturer. Do not use material or methods which may damage finish surface or surrounding construction

END OF SECTION 23 37 23
SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
1. Copper building wire rated 600 V or less.
2. Aluminum building wire rated 600 V or less.
3. Metal-clad cable, Type MC, rated 600 V or less.
4. Connectors, splices, and terminations rated 600 V and less.
B. Related Requirements:
1. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35,000 V.
2. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.
3. Section 271500 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Test Reports:
   1. Low-Voltage Cable Checklist
   2. Megger Test Report

1.3 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE
A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less. Comply with NEMA WC 70
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden Inc.
   2. Encore Wire Corporation.
3. General Cable Technologies Corporation.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

E. Conductor Insulation (90 Deg C):

1. Type THHN and Type THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

2.2 METAL-CLAD CABLE, TYPE LFMC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden Inc.
2. Encore Wire Corporation.
3. General Cable Technologies Corporation.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Wet Location Listed.
3. Comply with UL 1569.
4. RoHS compliant.
5. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:


E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Insulated.

G. Conductor Insulation:

1. Type TFN/THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.
H. Armor: Steel, interlocked.
I. Jacket: PVC applied over armor.

2.3 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. 3M Electrical Products.
3. Ideal Industries, Inc.
4. TE Connectivity Ltd.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Factory fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated.

E. High pressure crimp connectors shall be used for #6 AWG and larger conductors. Connectors shall be color keyed with insulating sealing collars. Split bolt type connectors will not be acceptable.

PART 3 - EXECUTION

3.1 EXISTING WORK

A. Remove exposed abandoned wire and cable. Patch surfaces where removed cables pass through building finishes.

B. Disconnect abandoned circuits and remove circuit wire and cable. Remove abandoned boxes when wire and cable servicing boxes is abandoned and removed. Install blank cover for abandoned boxes not removed.

C. Provide access to existing wiring connections remaining active and requiring access. Modify installation or install access panel.

D. Extend existing circuits using materials and methods compatible with existing electrical installations, or as specified.

E. Clean and repair existing wire and cable remaining or wire and cable to be reinstalled.

3.2 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
C. Power-Limited Fire Alarm and Control: Copper, Solid for No. 12 AWG and smaller.

3.3 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2 single conductors in raceway.
C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
D. Feeders in Cable Tray: TC-Rated Type XHHW-2, single conductors.
E. Class 1 and Class 2 Control Circuits: Type THHN/THWN-2, single conductors in raceway.
F. Branch Circuits Concealed in Ceilings, Walls, and Partitions:
   1. Type THHN/THWN-2 single conductors in raceway.
G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

3.4 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
3.6 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 VOLTAGE DROP REQUIREMENTS

A. Feeders: Feeders shall be sized for maximum voltage drop of 2%.

   1. All feeder sizes are to be called out on project drawings. Consult engineer for feeder sizes not noted on project drawings.

B. Branch circuits:

   1. Do not use wire smaller than No. 12 AWG (unless otherwise noted) for branch circuit wiring, including motor circuits.

   2. All 20 amp, 120 volt and 277 volt branch circuit homeruns (to panelboard) serving receptacles, equipment and lighting shall be No. 10 AWG minimum.

   3. Branch circuits shall be sized based on the anticipated load (not necessarily overcurrent protection), such that voltage drop does not exceed 3%.

   4. Size 120V, 15A/20A branch breaker, circuits for length of run on the following basis:

      a. 0 to 150 ft. run from panelboard to first outlet: No. 10 AWG minimum.

      b. 151 to 220 ft. run: increase one wire size, i.e.; No. 10 AWG becomes No. 8 AWG to first outlet.

      c. 221 to 270 ft. run: wiring shall be No. 6 AWG minimum size to first outlet.

3.9 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

3.10 FIELD QUALITY CONTROL

A. Tests and Inspections:

   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors.

   2. Perform the following visual and mechanical inspection and electrical tests:

      a. Verify cable data and wire sizes with drawings and specifications.
b. Inspect cables for damage and correct connections per one line diagrams.
c. Verify tightness of connections, and test connections for high resistance.
d. Inspect for correct phase arrangements and jacket insulation.

END OF SECTION 26 05 19
SECTION 26 05 23 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Backboards.
   2. Category 6 balanced twisted pair cable.
   3. Balanced twisted pair cabling hardware.
   4. RS-485 cabling.
   5. Low-voltage control cabling.
   7. Fire Alarm Cable.

1.2 DEFINITIONS
A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For testing agency, layout technician, installation supervisor, and field inspector.
   B. Source quality-control reports.
   C. Field quality-control reports.

1.5 QUALITY ASSURANCE
A. Testing Agency Qualifications: Accredited by NETA.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inches or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

E. RoHS compliant.

2.2 BACKBOARDS

A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.

B. Painting: Paint plywood on all sides and edges with two coats of eggshell gray alkyd paint.

2.3 CATEGORY 6 BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden Inc.
2. Berk-Tek Leviton; a Nexans/Leviton alliance.
3. CommScope, Inc.
4. General Cable; General Cable Corporation.
5. SYSTIMAX Solutions; a CommScope Inc. brand.
6. Hubbell Premise Wiring.
7. Panduit Corp.
8. Superior Essex Inc.

C. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 6 cables.

D. Conductors: 100-ohm, 24 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Cable Rating: Riser/Plenum.

G. Jacket: Blue thermoplastic.
2.4 BALANCED TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AMP NETCONNECT; a TE Connectivity Ltd. company.
2. Belden CDT Networking Division/NORDX.
3. Berk-Tek Leviton; a Nexans/Leviton alliance.
4. General Cable; General Cable Corporation.
5. Hubbell Premise Wiring.
6. Panduit Corp.
7. Superior Essex Inc.

C. General Requirements for Balanced Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

D. Source Limitations: Obtain balanced twisted pair cable hardware from single source from single manufacturer. Cable and hardware manufacturer’s shall include a combined 10 year warranty.

E. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

F. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

G. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:
   a. Universal T568A and T568B wiring labels.
   b. Labeling areas adjacent to conductors.
   c. Replaceable connectors.
   d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
3. Number of Jacks per Field: One for each four-pair cable indicated plus spares and blank positions adequate to suit specified expansion criteria.

H. Patch Cords: Factory-made, four-pair cables in 48-inch lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.
I. Plugs and Plug Assemblies:
   1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
   2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
   3. Marked to indicate transmission performance.

J. Jacks and Jack Assemblies:
   1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
   2. Designed to snap-in to a patch panel or faceplate.
   3. Standards: Category 6, unshielded balanced twisted pair cable shall comply with IEC 60603-7-Requirement below is optional in TIA-568-C.1.
   4. Marked to indicate transmission performance.

K. Faceplate:
   1. Two port, vertical single gang faceplates designed to mount to single gang wall boxes.
   2. Eight port, vertical double gang faceplates designed to mount to double gang wall boxes.
   3. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 “Wiring Devices.”
   4. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.
      a. Flush mounting jacks, positioning the cord at a 45-degree angle.

L. Legend:
   1. Machine printed, in the field, using adhesive-tape label.
   2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.
   1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   2. Fluorinated ethylene propylene insulation.
   3. Unshielded.
   4. Fluorinated ethylene propylene jacket.

2.6 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with NFPA 262.
2.7 CONTROL-CIRCUIT CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden
   2. Encore Wire Corporation.
   3. General Cable; General Cable Corporation.

B. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
   1. Smoke control signaling and control circuits.

2.8 FIRE ALARM CABLE

A. Plenum-Rated, Shielded Cable: NFPA 70, Type FPLP.
   1. Multi-pair, solid copper conductors per ASTM B3.
   2. No. 18 AWG through 12 AWG as required for Voltage Drop
   3. Low Smoke Color Coded Polypropylene or PVC insulation.
   4. Foil Shield.
   5. Red PVC jacket.

2.9 SOURCE QUALITY CONTROL

A. Factory test balanced twisted pair cables according to TIA-568-C.2.

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.
   1. Test each pair of twisted pair cable for open and short circuits.
3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
2. Outlet boxes shall be no smaller than 4 inches square by 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
3. Flexible metal conduit shall not be used.

B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.


11. Support: Do not allow cables to lay on removable ceiling tiles.

12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

13. Provide strain relief.

14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.

15. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:


2. Install termination hardware as specified in Section 271513 "Communications Copper Horizontal Cabling" unless otherwise indicated.

3. Do not untwist UTP cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.

2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.

3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.
3.7 GROUNDING
A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION
A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.
C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

3.9 FIELD QUALITY CONTROL
A. Tests and Inspections:
   1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
B. End-to-end cabling will be considered defective if it does not pass tests and inspections.
C. Prepare test and inspection reports.

END OF SECTION 26 05 23
SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes grounding and bonding systems and equipment.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Field Test Reports:
   1. Measure Ground Resistance
   2. Grounding and Bonding Installation Checklist

C. As-Built Drawings: Update grounding floor plans, locations of ground bars, tails and grounding risers/details.

D. O&M Data

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

C. Bonding Conductor: #4 or #6 AWG, stranded.

D. Bonding Jumper: Copper tape, braided conductors with copper ferrules; 1-5/8" wide x 1/16" thick.

E. Grounding Bus: Rectangular bars of annealed copper, 1/4" x 2" x 12", unless otherwise indicated mounted on insulators.
2.3 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.

D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

F. Conduit Hubs: Mechanical type, terminal with threaded hub.

G. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

H. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

I. Straps: Solid copper, copper lugs. Rated for 600 A.


PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground: Install bare copper conductors, #3/0 AWG (unless notes otherwise on project drawings), minimum 30” below grade.

C. Isolated Ground: Green insulation with yellow stripe

D. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Exothermic-welded connectors or irreversible compression connectors unless otherwise noted in project drawings.
   3. Connections to Structural Steel: Exothermic-welded connectors or clamp connectors unless otherwise noted in project drawings.
   4. Connections to Ground Rods at Test Wells: Bolted connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.
B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear/switchboard, motor control center, or distribution panel to equipment grounding bar terminal on busway.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including exhaust fans, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each point of connection.

B. Grounding system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify owner promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26
Not to be used for bidding purposes
SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Steel slotted support systems.
   2. Conduit and cable support devices.
   3. Support for conductors in vertical conduit.
   4. Structural steel for fabricated supports and restraints.
   5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
   6. Fabricated metal equipment support assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   2. Slotted support systems.
   3. Equipment supports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

   1. Flame Rating: Class 1.
   2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. B-line, an Eaton business.
      b. Flex-Strut Inc.
c. G-Strut.
d. Thomas & Betts Corporation; A Member of the ABB Group.
e. Unistrut; Part of Atkore International.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Material for Channel, Fittings, and Accessories: Galvanized steel in Control and Electrical Rooms; Stainless steel, Type 316 in all other areas.
4. Channel Width: Selected for applicable load criteria - 1-5/8 inches, 1-1/4 inches, or 13/16 inches.
5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-stainless-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hilti, Inc.
      2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.

2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) B-line, an Eaton business.
      2) Hilti, Inc.
      3) ITW Ramset/Red Head; Illinois Tool Works, Inc.
3. Concrete Inserts: Stainless-Steel, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA 101
3. NECA 102.
4. NECA 105.
5. NECA 111.

B. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for conduit as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with stainless-steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

F. Spring-stainless-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Material for Channel, Fittings, Anchors and Accessories: Galvanized steel in Control and Electrical Rooms; Stainless steel, Type 316 in all other areas.
B. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

C. Raceway Support Methods: In addition to methods described in NECA 1, RMC may be supported by openings through structure members, according to NFPA 70.

D. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
   6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 or Spring-tension clamps.
   7. To Light Steel: Sheet metal screws.
   8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

F. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M.
SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal conduits and fittings.
   2. Nonmetallic conduits and fittings.
   3. Metal wireways and auxiliary gutters.
   4. Nonmetal wireways and auxiliary gutters.
   5. Boxes, enclosures, and cabinets.

B. Related Requirements:
   1. Section 07 84 13 "Penetration Firestopping" for firestopping at conduit and box entrances.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:
   1. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. EMT and IMC are not permitted on this project.
   2. GRC/RMC: Comply with ANSI C80.1 and UL 6.
   3. PVC-Coated Steel Conduit: PVC-coated RMC.
      a. Comply with NEMA RN 1.
      b. Coating Thickness: 0.040 inch, minimum.
   4. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings: Comply with NEMA FB 1 and UL 514B.
   1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Fittings, General: Listed and labeled for type of conduit, location, and use.

4. Fittings for RMC:
   a. Material: Steel or die cast.
   b. Type: Setscrew or compression.

5. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

6. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

C. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

3. LFNC: Comply with UL 1660.

B. Nonmetallic Fittings:

1. Fittings, General: Listed and labeled for type of conduit, location, and use.

2. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

3. Fittings for LFNC: Comply with UL 514B.

4. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line, an Eaton business.

2. Hoffman; a brand of Pentair Equipment Protection.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 4 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carlon Electrical Products.
3. Panduit Corporation.
4. Hoffman; a brand of Pentair Equipment Protection.

B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, and caps, and other fittings shall match and mate with wireways as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. FSR Inc.
2. Hoffman; a brand of Pentair Equipment Protection.
3. Hubbell Incorporated.
4. Thomas & Betts Corporation; A Member of the ABB Group.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 4X with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Stainless Steel.
2. Interior Panels: Stainless Steel.

L. Cabinets:

1. NEMA 250, Type 4X stainless-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC/RMC.
2. Concealed Conduit, Aboveground: GRC/RMC.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed: GRC/RMC in Control and Electrical Rooms; PVC Coated RMC in all other locations.
2. Concealed in Ceilings and Interior Walls and Partitions: RMC.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
4. Boxes and Enclosures: NEMA 250, Type 4X stainless steel in all locations.

C. Minimum Raceway Size:

1. ¾-inch trade size except for switch legs and control circuits may be ½ inch.
2. Homerun conduit size shall be 1" trade size minimum.
3. Minimum FMC size shall be ½", except that lighting fixture connections may be 3/8".

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. RMC: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

F. Arrange stub-ups so curved portions of bends are not visible above finished slab.

G. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

H. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

I. Conceal conduit and RMC within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

J. Support conduit within 12 inches of enclosures to which attached.

K. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.

4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

5. Change from ENT to GRC before rising above floor.

L. Stub-ups to Above Recessed Ceilings:

1. Use RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

N. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

R. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.

S. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct and equipment.
5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6. Where otherwise required by NFPA 70.

T. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per degree F of temperature change for PVC conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
U. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

V. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.

W. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

X. Locate boxes so that cover or plate will not span different building finishes.

Y. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

Z. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

AA. Set metal floor boxes level and flush with finished floor surface.

BB. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit.

2. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.

3. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.

   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

4. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
3.5  **FIRESTOPPING**

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.6  **PROTECTION**

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

**END OF SECTION 26 05 33**
SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS
FOR ELECTRICAL RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   5. Silicone sealants.

B. Related Requirements:
   1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.
2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. CALPICO, Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel.

4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, or Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.


C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using galvanized steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical
sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44
SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Color and legend requirements for raceways, conductors, and warning labels and signs.
   2. Conduit Labels.
   3. Tags.
   4. Signs.
   5. Cable ties.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Label for arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS


B. Comply with NFPA 70.


D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70E and Section 26 05 73 "Electrical Coordination Study" requirements for arc-flash warning labels.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:
   1. Black letters on an orange field.
   2. Legend: Indicate voltage.

B. Warning Label Colors:
   1. Identify system voltage with black letters on an orange background.

C. Warning labels and signs shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

D. Equipment Identification Labels: Black letters on a white field.

2.3 CONDUIT LABELS

A. General Requirements for Manufactured Conduit Labels: Preprinted, color-coded, and alphanumeric characters indicating system and voltage, per review and coordinate with owner.

B. Approved Manufacturer: Seton, Kolbi Pipe Marker Co. or equal.

C. Pretensioned Conduit Labels: Precut, semi-rigid plastic formed to cover full circumference of conduit and to attach to conduit without fasteners or adhesive.

D. Self-Adhesive Conduit Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Conduit Label Contents: Include identification of conduit service using same designations or abbreviations as used on Drawings.
   1. Lettering Size: ¾-inch minimum on conduits with OD less than 6 inches.

2.4 TAGS

A. Write-on Tags:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Carlton Industries, LP.
      b. LEM Products Inc.
   2. Polyester Tags: 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment.
   3. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
   4. Marker for Tags: Machine printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
2.5 SIGNS

A. Baked-Enamel Signs:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Carlton Industries, LP.
      b. Champion America.
      c. Emedco.
   2. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
   3. 1/4-inch grommets in corners for mounting.
   5. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Brady Corporation.
      b. Carlton Industries, LP.
      c. Emedco.
   7. Thickness:
      a. For signs up to 20 sq. in., minimum 1/16 inch thick.
      b. For signs larger than 20 sq. in., 1/8 inch thick.
      c. Engraved legend with black letters on white face.
      d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
      e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 CABLE TIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. HellermannTyton.
   2. Ideal Industries, Inc.
   3. Marking Services, Inc.
   B. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
      2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
      3. UL 94 Flame Rating: 94V-0.
      4. Temperature Range: Minus 50 to plus 284 deg F.
      5. Color: Black.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.
PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Junction Boxes, 600 V or Less, for Service, Feeder, and Branch Circuits: Identify with paint as noted below. Confirm coloring coding scheme.
   1. All junction boxes for the Emergency System and Fire Alarm System shall be painted as follows:
      a. Low Voltage Control Systems - ANSI/OSHA Safety Blue (Rust-Oleum #7524838)
      b. Medium Voltage – Normal Power – ANSI/OSHA Safety Orange (Rust-Oleum #7555838)
      c. Fire Alarm System – ANSI/OSHA Safety Red (Rustoleum #7564838)
   2. Junction boxes and covers shall be painted with the color of the applicable system. In public exposed areas that are painted only, the interior of the junction box and cover shall be painted with the system color.

B. Power-Circuit Conductor Identification: For primary and secondary conductors in pull boxes, junction boxes and manholes/handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single circuit cables, identify phase in addition to the above.

C. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number.

D. At each junction box, the covers on junction boxes and pull boxes in areas that are not to be painted shall be marked with "Indelible Markers" to indicate the circuit number(s) of conductors in the box. In areas where exposed conduit and junction boxes are to be painted, indicate circuit number(s) of conductors in the box on the inside cover of the box.

E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source and circuit number.

F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and communications cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
   1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
      a. Power transfer switches
      b. Controls with external control power connections.
   2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

H. Instruction Signs:
1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer load shedding.

I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

   1. Labeling Instructions:
      a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with ½-inch high letters on 1-1/2-inch-high label; where 2 lines of text are required, use labels 2 inches high.
      b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
      c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

   2. Equipment to Be Labeled:
      a. Panelboards, electrical cabinets, and enclosures.
      b. Access doors and panels for concealing electrical items.
      c. Electrical switchgear and switchboards.
      d. Transformers.
      e. Disconnect switches.
      f. Enclosed circuit breakers.
      g. Motor starters and VFDs.
      h. Power transfer equipment.
      i. Contactors.
      j. Remote-controlled switches, dimmer modules, and control devices.
      k. Power-generating units.

J. Engraved laminate signs shall have colors and lettering as follows:
   1. Under 600V - Normal Power - Black field with white lettering.
   2. Over 600V - Normal Power – Orange field with black lettering.
   3. All other Equipment – Black field with white lettering.

K. Where the electrical system is comprised of normal power and emergency power, the equipment connected to the normal power system shall have engraved laminate signs with white lettering in a black field. Equipment connected to the emergency power system shall have engraved laminate signs with black lettering in a yellow field.

L. Panelboard identification shall indicate building name, panelboard designation, voltage and where fed from, e.g:

```
CP-1
277/480V, 3 PHASE, 4WIRE
FED FROM MCC-1
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M. Panelboards shall have floor space per NFPA 70 (NEC) permanently marked and shall be identified as "Electrical Working Space".

3.2 COVER PLATES

A. All wiring device cover plates shall have panel name and circuit number serving device clearly marked (e.g. "LP-7") on the back of each faceplate with indelible marker.

3.3 PANELBOARD CIRCUIT DIRECTORIES

A. Install in each panelboard a typewritten directory accurately indicating rooms and equipment being served. Verify actual room names and numbers to be used. Also, provide a copy of typewritten panelboard directories in Owner's close-out manuals.

3.4 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after finish work is completed.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.

2. Colors for 208/120-V Circuits:
   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.
   e. Ground: Green.
   f. Isolated Ground: Green/Yellow Tracer.

3. Colors for 480/277-V Circuits:
   b. Phase B: Orange.
   c. Phase C: Yellow.
   d. Neutral: Gray.
   e. Ground: Green.
   f. Isolated Ground: Green/Yellow Tracer.

4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or
taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

H. Painted Identification: Prepare surface and apply paint according to Section 09 – “Paintings and Coatings”.

I. Conduit Label Installation
   1. Conduit labels shall be used on emergency circuits, 277 volt lighting homeruns, communication and feeders.
   2. Locate conduit labels where conduit is exposed or above accessible ceilings in finished spaces; and Electrical rooms as follows;
      a. Near each floor and ceiling penetration.
      b. Near each junction box or pull box.
      c. Near major equipment items and other points of origination and termination.
      d. Spaced at maximum intervals of 100 feet along each run. Reduce intervals to 50 feet in areas of congested conduit and equipment.
      e. On conduit above removable acoustical ceilings. Omit immediately spaced labels.
      f. Labels shall not be utilized in public spaces.

END OF SECTION 26 05 53
Not to be used for bidding purposes
SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Straight-blade convenience receptacles.
2. Toggle switches.
3. Wall plates.

1.2 DEFINITIONS

A. Abbreviations of Manufacturers' Names:

1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
C. Samples: One for each type of device and wall plate specified, in each color specified.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

D. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STRAIGHT-BLADE RECEPTACLES

A. Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596. Class 1, Division 1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.

2.3 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A, Class 1 Division 1 where applicable:

1. Single Pole:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Eaton (Arrow Hart).
      2) Hubbell Incorporated; Wiring Device-Kellems.
      3) Leviton Manufacturing Co., Inc.

C. Pilot-Light Switches, 120/277 V, 20 A, Class 1 Division 1 where applicable:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.

2. Description: Single pole, with LED-lighted handle, illuminated when switch is on.

D. Provide Hazardous Location rated devices (Class 1 Division 1) where indicated on plans.
2.4 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Type 302 stainless steel 0.04-inch-thick.
4. Material for Damp Locations: Stainless Steel with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, stainless steel with lockable cover.

C. Provide Hazardous Location rated devices (Class 1 Division 1) where indicated on plans.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA-1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

**Receptacle Orientation:**
1. Install ground pin of vertically mounted receptacles down.

**Device Plates:** Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

### 3.2 FIELD QUALITY CONTROL

**A. Test Instruments:** Use instruments that comply with UL 1436.

**B. Test Instrument for Convenience Receptacles:** Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

**C. Perform the following tests and inspections:**
1. Tests for Convenience Receptacles:
   a. Line Voltage: Acceptable range is 105 to 132 V.
   b. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
   c. Ground Impedance: Values of up to 2 ohms are acceptable.
   d. Using the test plug, verify that the device and its outlet box are securely mounted.
   e. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

**D. Wiring device will be considered defective if it does not pass tests and inspections.

**E. Prepare test and inspection reports.**

**END OF SECTION 26 27 26**
SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Cartridge fuses rated 600 V ac and less for use in the following:
         a. Control circuits.
         b. Motor-control centers.
         c. Enclosed controllers.
         d. Enclosed switches.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product.

1.3 CLOSEOUT SUBMITTALS
   A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Bussmann, an Eaton business.
      2. Littelfuse, Inc.

2.2 CARTRIDGE FUSES
   A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
      1. Type RK-1: 250 or 600-V, zero- to 600-A rating, 200 kAIC, time delay.
      2. Type RK-5: 250 or 600-V, zero- to 600-A rating, 200 kAIC, time delay.
      3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.
      4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC, fast acting.
      5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
      6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
      7. Type T: 250-V, zero- to 1200-A/600-V, zero- to 800-A rating, 200 kAIC, very fast acting.

Not to be used for bidding purposes
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

F. Complete Coordination Study per Section 260573 to determine fuse sections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Provide 20% spare fuses for each type to Owner.

3.2 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13
SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Enclosures.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years.
PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.2 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D.

B. Type HD, Heavy Duty:

1. Single throw.
2. Three pole.
3. 600-V ac.
4. 200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
6. Lockable handle with capability to accept padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.

2.3 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
B. Enclosure Finish: The enclosure shall be NEMA 250 Type 9 a brush finish on Type 316 stainless steel.

C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

D. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

2.4 CIRCUIT BREAKERS (FEEDER BUCKET) FOR MOTOR CONTROL CENTER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Siemens (Model 95 MCC).

B. Type TIASTAR, Custom DFCB:
   1. (2) Single throw breakers.
   2. Three pole.
   3. 600-V ac.
   4. (1) 40 A and (1) 100A Frames, Adjustable Trip Settings.
   5. 65 Kaic Rated.
   6. 12” High x 20” Wide (Verify in Field)
   7. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
   8. Lockable handle with capability to accept padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
PART 3 - EXECUTION

3.1 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.

1. Hazardous Areas Indicated on Drawings: NEMA 250, Type 9 with cover attached by Type 316 stainless steel bolts.

3.2 INSTALLATION

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner unless complying with general requirements

1. Comply with NFPA 70E.

B. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

D. Install fuses in fusible devices.

E. Comply with NFPA 70 and NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Perform tests and inspections.

D. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:
   a. Inspect physical and mechanical condition.
   b. Inspect anchorage, alignment, grounding, and clearances.
   c. Verify that the unit is clean.
   d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.

f. Verify that each fuse has adequate mechanical support and contact integrity.

g. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

    a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

    a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.

i. Verify correct phase barrier installation.

j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

3. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate
values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.

e. Determine the following by primary current injection:

1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.

g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.

h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.

i. Verify operation of charging mechanism. Investigate units that do not function as designed.

4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 28 16
SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Special Conditions, Mechanical and Electrical Supplemental Requirements 2000 00 and Division 01 Specification Sections, apply to this section.

1.2 RELATED WORK AND REQUIREMENTS

A. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
B. Section 26 05 53 - Identification for Electrical Systems
C. Section 26 28 13 – Fuses
D. Section 26 28 16 - Enclosed Switches and Circuit Breakers

1.3 SUMMARY

A. The Section includes ac, enclosed controllers rated 600 V and less, of the following types: Across-the-line, manual and magnetic controllers.

B. Related Sections include the following:
   1. Section 23 09 00 – “Instrumentation and Control for HVAC” for interfacing communication and metering requirements.
   2. Section 26 29 23 - “Variable-frequency Motor Controllers” for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on constant torque loads in ranges up to 200 hp.

1.4 SUBMITTALS

A. Shop Drawings: For each enclosed controller.
   1. Include enclosure dimensions, elevations, sections, wiring diagrams, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit’s type and details.
      b. Thermal unit schedule.
      c. Nameplate legends.
      d. Short-circuit current rating of integrated unit.
      e. Overcurrent protective devices in combination controllers.
      f. Features, characteristics, electrical ratings, and factory settings of individual overcurrent protective devices in combination controllers.
      g. Product data sheets with written installation instructions.
      h. Identify with tag number for proposed use.
   2. Wiring Diagrams: Power, signal, and control wiring.
B. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Specification Section 01 78 23 - Operation and Maintenance Data, include the following:

1. Manufacturer's printed instructions for replacing parts, performing cleaning, and operating and maintaining motor starters.
2. Repair parts list.
3. Field quality control test results.
4. Routine maintenance requirements for enclosed controllers and all installed components.
5. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

C. Load-Current and thermal overload List: Compile after motors have been installed and arrange to demonstrate that selection of thermal overloads suits actual motor nameplate full-load currents.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Requirements of Regulatory Agencies:

1. Comply with NFPA 70.


1.6 DELIVERY, STORAGE AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. Do not store in areas subject to weather.

C. Protect motor starters against damage from work of other trades.

1.7 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
C. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
2. Indicating Lights: 25% of each type installed, but no less than two of each type installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. The listing of a manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.

1. Square D.
2. General Electric.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLE

A. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.

2. Circuit breaker interlocked with cover, mounted in common enclosure, of types, ratings, and NEMA sizes required to match motor horsepower.
3. Equip starters with block type manual reset overload relays and with circuit breaker.
4. Provide operating handle for disconnect switch mechanism with indication and control of switch position, with enclosure door either opened or closed, and capable of being locked in OFF position, with a padlock.
5. Starter characteristics shall be the same as specified for magnetic controllers.
6. Provide other accessories as indicated elsewhere in this specification.

2.3 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. Provide flush enclosures where starters are located in finished spaces and surface enclosures where starters are located in unfinished areas.

1. Indoor Locations: NEMA 250, Type 12.

2.4 ACCESSORIES

A. All magnetic combination non-reversing starters shall be provided with the following. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
1. Overload Relay: Provide three phase solid state overload relay with inherent phase loss and unbalance protection. Size from motor nameplate full load amperage. Unit to be equal to Square D type Motor Logic, Class 20.

2. Provide three phase bi-metallic overload relay with inherent phase loss and unbalance protection. Overload relay shall have automatic resetting capability. Size from motor nameplate full load amperage. Unit to be equal to Square D, Class 20.

   a. Pilot lights, transformer type - “red” mounted on door to indicate motor running.
   b. Selector switch, 3 position (Hand-Off-Automatic), manual return. Where noted on drawings, starters for exhaust fans shall have a 2 position selector switch, off-automatic.

4. Legend plates, standard, with legends as indicated.

5. Provide on normally open and two normally closed auxiliary contacts.

6. Control circuits:
   a. Voltage not to exceed 120V.
   b. Control transformer mounted in starter enclosure.
   c. Primary fusing
   d. Fuses on secondary line.
   e. One secondary line grounded.
   f. Transformer sized for device accessories connected thereto and 25% extra capacity minimum. Minimum size shall be 50 VA.
   g. All starters with control circuits which derive their power from a source other than from the starter itself shall be complete with an auxiliary control circuit disconnect (ACCD) to de-energize the circuit whenever the door or cover to the starter is opened. In the case of combination starters, an auxiliary contact or fourth pole may be added to the disconnect switch in lieu of the ACCD.


2.5 SHORT CIRCUIT RATING

A. Short Circuit Rating: The short circuit current rating of the combination starter shall be the same as the upstream overcurrent protection device protecting the starter.

2.6 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 INSTALLATION

A. Install in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation" and in accordance with recognized practices.

B. Install by mounting firmly to wall or structural surface.

C. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Section 26 28 13 - Fuses.

3.3 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Section 26 05 53 - Identification of Electrical Systems.

3.4 CONTROL WIRING INSTALLATION

A. Control wiring, regardless of voltage, shall be the responsibility of the contractor supplying the motor, unless specifically noted otherwise.

3.5 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

3.6 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Megger check of phase-to-phase and phase-to-ground insulation levels. Do not megger check solid state equipment.
   2. Continuity.
   3. Operational check.
   4. Test each motor and permanently record the following information. Provide schedule with close-out documents.
      a. Motor identification per motor schedule.
      b. Nameplate data.
      c. Overcurrent protection thermal unit - type and size.
      d. Protective relay (if any) setting.
      e. Motor starter overcurrent protective device (if any) - type and size.
      f. Voltage and current phase readings.
      g. Direction of rotation.
      h. Motor starter short circuit rating.
   5. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
   6. Test continuity of each circuit.
7. Perform each electrical test and visual and mechanical inspection, stated in NETA ATS, "Motor Control - Motor Starters." Certify compliance with test parameters.
8. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.7 ADJUSTING AND CLEANING

A. Adjust covers and operating mechanisms for free mechanical movement.
B. Tighten wire and cable connections.
C. Verify overcurrent protection thermal unit size with motor nameplate to provide proper operation and compliance with NEC.
D. Clean interior of enclosure.
E. Touch up paint scratched and marred surfaces to match original finish.

3.8 DEMONSTRATION

A. Train Owner’s maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 26 29 13
SECTION 26 29 23 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, inverter duty motors.

1.3 DEFINITIONS

A. CPT: Control power transformer.
B. DDC: Direct digital control.
C. EMI: Electromagnetic interference.
D. LED: Light-emitting diode.
E. NC: Normally closed.
F. NO: Normally open.
G. OCPD: Overcurrent protective device.
H. PID: Control action, proportional plus integral plus derivative.
I. RFI: Radio-frequency interference.
J. VFC: Variable-frequency motor controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.
   1. Include dimensions and finishes for VFCs.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.
   1. Include mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS


B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.
   1. Manufacturer’s written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
   2. Manufacturer’s written instructions for testing, adjusting, and reprogramming microprocessor control modules.
   3. Manufacturer’s written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Control Power Fuses: Furnish two of each size and type.
   2. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
   3. Power Contacts: Furnish one spare for each size and type of magnetic contactor installed.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store in a space that is permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB (Electrification Products Division).
2. Danfoss Inc.

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:

1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

B. Application: variable torque.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 5 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
8. Humidity Rating: Less than 95 percent (noncondensing).
10. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
11. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
12. Speed Regulation: Plus or minus 5 percent.
13. Output Carrier Frequency: Selectable; 0.5 to 2.5 kHz.
14. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
   1. Signal: Electrical through DDC.

I. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:
   1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 2.
   2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
   4. Inverter overcurrent trips.
   5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
   6. Critical frequency rejection, with three selectable, adjustable deadbands.
   7. Instantaneous line-to-line and line-to-ground overcurrent trips.
  10. Short-circuit protection.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

O. Integral Input Disconnecting Means and OCPD: UL 489, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.
   1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
   2. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
   3. NO alarm contact that operates only when circuit breaker has tripped.
2.3 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.
   5. Overcurrent.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
   1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
   2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
      a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:
   1. Running log of total power versus time.
   2. Total run time.
   3. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
   1. Output frequency (Hz).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (V dc).
   9. Set point frequency (Hz).
   10. Motor output voltage (V ac).

E. Control Signal Interfaces:
   1. Electric Input Signal Interface:
      a. A minimum of six multifunction programmable digital inputs.
   2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
      a. 0- to 10-V dc.
      b. 4- to 20-mA dc.
      c. Potentiometer using up/down digital inputs.
d. Fixed frequencies using digital inputs.

3. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc, which can be configured for any of the following:
   a. Output frequency (Hz).
   b. Output current (load).
   c. DC-link voltage (V dc).
   d. Motor torque (percent).
   e. Motor speed (rpm).
   f. Set point frequency (Hz).

4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
   a. Motor running.
   b. Set point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

F. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC’s nonvolatile memory.

1. Communication Interface: Comply with ASHRAE 135 Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.

2.4 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the manufacturer’s harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

2.5 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.

C. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller.

3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.


1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.
3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
   a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
   b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
   a. CPT Spare Capacity: 100 VA.
   a. Solid-State Overload Relays:
      1) Switch or dial selectable for motor-running overload protection.
      2) Sensors in each phase.
      3) Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
   b. External overload, reset push button.

2.6 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
1. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA Type 12.

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
B. VFCs will be considered defective if they do not pass tests and inspections.
C. Provide test and inspection reports.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 26 05 29 "Hangers and Supports for Electrical Systems."
B. Install, connect, and fuse thermal-protector monitoring relays and DDC interface furnished with motor-driven equipment.
C. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION
A. Install wiring between VFCs and remote devices, and DDC Controller. Comply with requirements in Section 26 05 23 "Control-Voltage Electrical Power Cables."
B. Bundle, train, and support wiring in enclosures.
C. Connect selector switches and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
   2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.
3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages.
5. Test each motor for proper phase rotation.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
3.7 **ADJUSTING**

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field adjustable pressure switches.

3.8 **PROTECTION**

A. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 **DEMONSTRATION**

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

**END OF SECTION 26 29 23**
SECTION 26 41 00 - LIGHTNING PROTECTION SYSTEM

PART 1 GENERAL

1.1 REFERENCES

A. NFPA 70 - (2014) National Electrical Code
C. UL 467 - (2013) Grounding and Bonding Equipment
D. UL 96 - (2016) Standard for Lightning Protection Components
E. UL 96A - (2016) Standard for Installation Requirements for Lightning Protection Systems

1.2 SYSTEM REQUIREMENTS

A. The existing building does not currently have a Lightning Protection System and requires a complete installation. Materials shall consist of standard products of a manufacturer regularly engaged in production of lightning protection systems using the manufacturer’s latest UL approved design. Lightning protection system and materials shall conform to NFPA 70, NFPA 780, UL 96 and UL 96A.

1.3 QUALITY ASSURANCE

A. Installation Drawings
   1. Submit installation drawings for the overall lightning protection system. Drawings shall include all existing grounding components that will remain along with the physical layout of the new equipment, dimensions, mounting details, relationship to other parts of the work, and wiring diagram.
   2. Submit detail drawings for each major component to include manufacturer’s descriptive and technical literature, catalog cuts, and installation instructions.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, and marked for intended used.

1.4 SUBMITTALS FOR REVIEW/RECORD

A. Product Data

1.5 SUBMITTALS FOR RECORD ONLY

A. Test Reports:
   1. Measure Ground Resistance
   2. Grounding and Bonding Installation Checklist

B. As-Built Drawings
PART 2 PRODUCTS

2.1 MATERIALS

A. Do not use a combination of materials that forms an electrolytic couple of such nature that corrosion is accelerated in presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, provide conductors with protective coatings. Where a mechanical hazard is involved, or protect conductors by covering them with molding or tubing made of wood or nonmagnetic material. When metallic conduit or tubing is provided, electrically bond conductor to conduit or tubing at the upper and lower ends by clamp type connectors or welds (including exothermic).

B. Lightning protection equipment, Accessories, and Hardware shall conform to NFPA 70, NFPA 780, and UL 96.

C. Main and Bonding Conductors: NFPA 780 and UL 96 - Size of conductors shall not be less than specified in NFPA 780.

D. For structures not exceeding 75 ft in height, comply with NFPA Class I conductor standards. Aluminum conductors shall be at least 98,600 Cir.Mils at 95 lbs per 1000 ft.

E. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

F. Do not allow aluminum to contact the earth and do not use in any other manner that will contribute to rapid deterioration of the metal. Observe appropriate precautions at connections with dissimilar metals in accordance with NFPA 70 Article 110-14.

2.2 COMPONENTS

A. Air Terminals

1. Provide terminals in accordance with UL 96. Support air terminals more than 24 inches in length by suitable brace, with guides, not less than one-half the height of the terminal.

2. Air terminals shall be 5/8-inch aluminum. Fasten air terminals to a aluminum connectors with a male threaded stud on which the female threaded air-terminal shaft shall be mounted.

3. Air terminals shall be not less than 10-inches high above the object to protect, tapered to a point. Separate points are not required on top of air terminals, but if used, the points shall be of substantial construction and securely attached by screw or slip joints. Air terminals more than 24-inches high shall be supported by a suitable brace with guide(s) not less than one-half the height of the air terminal.

B. Ground Rods

1. If additional ground rods are required, provide ground rods made of copper-clad steel, stainless steel, or solid copper conforming to UL 467. Contractor shall determine the soil resistance at the site; use galvanized ferrous rods conforming to ANSI C135.30 where low soil resistivity is encountered and use copper clad steel rods for normal soil resistance. Provide ground rods that are not less than 3/4 inch

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in diameter and 10 feet in length. Do not mix ground rods of copper-clad steel, stainless steel, galvanized ferrous, or solid copper on the same job.

C. Connections and Terminations

1. Provide connectors for splicing conductors that conform to UL 96. Conductor connections can be made by clamps or welds (including exothermic). Provide style and size connectors required for the installation of corrosion-resistant material (bimetallic) affording protection against electrolysis when joining dissimilar metals.

D. Connector Fittings: Provide connector fittings for “end-to-end”, “Tee”, or “Y” splices that conform to NFPA 780.

E. Lightning Protection Components: Provide bonding plates, air terminal supports, chimney bands, clips, and fasteners that conform to UL 96 classes as applicable.

2.3 MAIN AND SECONDARY CONDUCTORS

A. Concealed conductors shall be in accordance with NFPA 780 and UL 96 and shall be aluminum.

B. Do not allow aluminum to contact or touch the earth, dissimilar metals, or constructions where rapid deterioration of the metal could result. Observe precautions at connections with dissimilar metals.

2.4 CLAMP-TYPE CONNECTORS

A. Clamp connectors for splicing conductors shall conform to UL 96 and CID A-A-59213, Class 2 noninsulated, style and size as required for the installation. Connectors shall be of corrosion-resistant material and shall afford protection against electrolysis.

2.5 LIGHTNING PROTECTION COMPONENTS

A. Lightning protection components, such as bonding plates, air terminal supports, chimney bands, clips, and fasteners shall conform to UL 96, classes as applicable.

PART 3 EXECUTION

3.1 INTEGRAL SYSTEM

A. Lightning protection system consists of air terminals, roof conductors, down conductors, ground connections, grounding electrodes and ground loop conductor. Electrically interconnect lightning protection system to form the shortest distance to ground. Do not use non-conducting parts of the structure as part of the building's lightning protection system. Expose conductors on the structures except where conductors are required to be in protective sleeves. Interconnect secondary conductors with grounded metallic parts within the building. Make interconnections within side-flash distances at or above the level of the grounded metallic parts.

B. Air Terminals

1. Provide air terminal design and support conforming to NFPA 780. Rigidly connect terminals to, and make electrically continuous with, roof conductors by means of pressure connectors or crimped joints of T-shaped malleable metal. Provide pressure connector or crimped joint with a dowel or threaded fitting to connect ground rod conductor with air terminal. Set air terminals at ends of structures not...
more than 2 feet from ends of ridges and corners of roofs. Do not exceed 25 feet in spacing of 2 foot high or greater air terminals on ridges, parapets, and around perimeter of building with flat roofs or 20 feet in spacing of air terminals less than 2 feet high. When necessary to exceed this spacing, use taller air terminals and the rolling sphere method. On large flat, or gently sloping roofs, as defined in NFPA 780, place air terminals at points of the intersection of imaginary lines dividing the surface into rectangles having sides not exceeding 50 feet in length. Secure air terminals against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces which are permanently and rigidly attached to the building or structure. Metal projections, metal parts of buildings, and other metal objects that are at least 3/16 inch thick and that do not contain hazardous materials, need not be provided with air terminals. However, bond these metal objects to a lightning conductor through a metal conductor of the same unit weight per length as the main conductor. Where nonmetallic spires, steeples, or ventilators are present, mount air terminals to the side. In addition, where spires or steeples project more than 10 feet above the building, continue conductor from air terminal to nearest down conductor securely connect thereto.

C. Roof Conductors
1. Connect roof conductors directly to the roof or ridge roll. Avoid sharp bends or turns in conductors. Do not make turns of less than 8 inches radius. Preserve horizontal or downward course on conductors. Rigidly fasten conductors every 3 feet along the roof and down the building to the ground. Rigidly connect metal ventilators to the roof conductor at two places. Make connections electrically continuous. Course roof conductors along contours of flat roofs, ridges, parapets, and edges; and where necessary, over flat surfaces, in such a way as to join each air terminal to all the rest. Connect roof conductors surrounding tank tops, decks, flat surfaces, and flat roofs to form a closed loop.

D. Down Conductors
1. Measure the resistance to ground of the existing down conductors to verify compliance with NFPA 780; notify owner immediately if the existing down conductors are not in compliance. Make connections to existing down conductors electrically continuous from air terminals and roof conductors to grounding electrodes.

E. Interconnection of Metallic Parts: Connect metal flashing directly to ground or down conductors using not smaller than No. 4 aluminum conductor, or equivalent.

F. Ground Connections
1. Field verify secure connections and conductor forming continuations of existing down conductors from structure to grounding electrode in a manner to ensure electrical continuity between the two.

G. Grounding Electrodes
1. Field verify the serviceability of existing grounding electrodes for each down conductor. After the completed installation, measure the total resistance to ground using the fall-of-potential method described in IEEE 81. Maximum resistance of a driven ground rod shall be 10 ohms, under normally dry conditions and when a ground loop is not used.
2. Closely coordinate all ground rod location with the existing utilities located adjacent to the structure.
3.2 INTERFACE WITH OTHER STRUCTURES

A. Interconnection of Metal Bodies
   1. Protect rooftop mechanical equipment of conductance if not within the zone of
      protection of an air terminal. All metal bodies of conductance having an area of 400
      square inches or greater or a volume of 1000 cubic inches or greater shall be
      bonded to the lightning protection system using main size conductors and a bonding
      plate having a surface contact area of not less than 3 square inches. Metal bodies
      of inductance shall be bonded at their closest point to the lightning protection
      system using secondary bonding conductors and fittings. A metal body that
      exceeds 5 feet in any dimension, that is situated wholly within a building, and that
      does not at any point come within 6 feet of a lightning conductor or metal connected
      thereto shall be independently grounded.

3.3 RESTORATION

A. Where sod has been removed, place sod as soon as possible after completing the backfilling.
   Restore to original condition the areas disturbed by trenching, storing of dirt, cable laying,
   and other work. Include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging
   or mulching in any restoration. Maintain disturbed surfaces and replacements until final
   acceptance.

3.4 FIELD QUALITY CONTROL

A. Grounding System Test
   1. Test the grounding system to ensure continuity and that resistance to ground is not
      in excess of 10 ohms. Test the ground rod for resistance to ground before making
      connections to the rod. Tie the grounding system together and test for resistance to
      ground. Make resistance measurements in dry weather, not earlier than 48 hours
      after rainfall. Include in the written report: locations of ground rods, the ground
      resistance, and the soil conditions at the time that measurements were made.

B. Lightning Protection System Inspection
   1. Make visual inspections to verify that there are no loose connections which may
      result in high resistance joints, and that conductors and system components are
      securely fastened to their mounting surfaces and are protected against accidental
      mechanical displacement.

3.5 SYSTEM RATINGS

A. Lightning-protection systems conforming to the installation requirements of UL 96A shall be
   qualified for a UL "Master Label" rating. Installed lightning-protection system shall be
   inspected and approved by a certified UL inspector.

END OF SECTION 26 41 00
Not to be used for bidding purposes
SECTION 26 51 19 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)


ASTM INTERNATIONAL (ASTM)


ASTM A653/A653M (2015; E 2016) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process


ILLUMINATING ENGINEERING SOCIETY (IES)

IES HB-10 (2011; Errata 2015) IES Lighting Handbook


IES RP-16 (2010; Addendum A 2008; Addenda B 2009; Addendum C 2016) Nomenclature and Definitions for Illuminating Engineering
IES TM-21 (2011; Addendum B 2015) Projecting Long Term Lumen Maintenance of LED Light Sources

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)


NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2014) Enclosures for Electrical Equipment (1000 Volts Maximum)


NEMA C82.77 (2002) Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment

NEMA ICS 2 (2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V

NEMA ICS 6 (1993; R 2011) Enclosures

NEMA SSL 1 (2010) Electronic Drivers for Led Devices, Arrays, or Systems

NEMA SSL 3 (2011) High-Power White LED Binning for General Illumination


NEMA WD 1 (1999; R 2015) Standard for General Color Requirements for Wiring Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)


NFPA 70 (2017) National Electrical Code
UNDERWRITERS LABORATORIES (UL)

UL 1598 (2008; Reprint Oct 2012) Luminaires
UL 20 (2010; Reprint Feb 2012) General-Use Snap Switches
UL 508 (1999; Reprint Oct 2013) Industrial Control Equipment
UL 8750 (2009; Reprint May 2014) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products
UL 917 (2006; Reprint Aug 2013) UL Standard for Safety Clock-Operated Switches
UL 94 (2013; Reprint Jan 2016) Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Manufacturers’ Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   2. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.
   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

C. Samples: For each luminaire and for each color requiring custom finish.
1.3 INFORMATIONAL SUBMITTALS
   A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.
   B. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
   C. Product Certificates: For each type of luminaire.
   D. Product test reports.
   E. Sample warranty.

1.4 CLOSEOUT SUBMITTALS
   A. Operation and maintenance data.

1.5 QUALITY ASSURANCE
   A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
   B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
   C. Provide luminaires from a single manufacturer for each luminaire type.
   D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.6 WARRANTY
   A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
   B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Ambient Temperature: 5 to 104 deg F.
      1. Relative Humidity: Zero to 95 percent.
   B. Altitude: Sea level to 1000 feet.
2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp characteristics:
      a. “USE ONLY” and include specific lamp type.
      b. Lamp diameter, shape, size, wattage, and coating.
      c. CCT and CRI.

C. Recessed luminaires shall comply with NEMA LE 4.

D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

E. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

F. California Title 24 compliant.

2.3 LIGHTING FIXTURES.

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acuity Brands.
   2. Focal Point.

B. Nominal Operating Voltage: 120 V ac.

C. Lamp: See Fixture Schedule

D. Housings:
   1. Extruded-aluminum housing and heat sink.
   2. Anodized or powder-coat finish.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. With integral mounting provisions.

G. Standards:
   1. UL Listing: Listed for location.
   2. Recessed luminaires shall comply with NEMA LE 4.
H. Drivers: NEMA SSL 1, UL 8750. LED drivers must be electronic, UL Class 1, constant-current type and comply with the following requirements:

1. Output power (watts) and luminous flux (lumens) as shown in luminaire schedule for each luminaire type to meet minimum luminaire efficacy (LE) value provided.
2. Power Factor (PF) greater than or equal to 0.9 over the full dimming range when provided.
3. Current draw Total Harmonic Distortion (THD) of less than 20 percent.
4. Class A sound rating.
5. Operable at input voltage of 120-277 volts at 60 hertz.
6. Minimum 10 year manufacturer's warranty.
7. RoHS compliant.
8. Integral thermal protection that reduces or eliminates the output power if case temperature exceeds a value detrimental to the driver.
9. UL listed for dry or damp locations typical of interior installations.
10. Fully-dimmable using 0-10V control, or as indicated in luminaire schedule.

2.4 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Steel:

1. ASTM A 36/A 36M for carbon structural steel.
2. ASTM A 568/A 568M for sheet steel.

C. Stainless Steel:

1. Manufacturer's standard grade.
2. Manufacturer's standard type, ASTM A 240/240 M.

D. Galvanized Steel: ASTM A 653/A 653M.

E. Aluminum: ASTM B 209.

2.5 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning and relamping.
   3. Provide support for luminaire without causing deflection of ceiling or wall.
   4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.2 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
   2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 260923 - "Network Lighting Control Devices"
END OF SECTION 26 51 19
SECTION 28 46 21 - ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fire-alarm control unit.
   3. System smoke detectors.
   6. Addressable interface device.

B. Related Requirements:
   1. Section 27 05 13 "Conductors and Cables for Communications Systems" for cables and conductors for fire-alarm systems.

1.2 ACTION SUBMITTALS

A. General Submittal Requirements:
   1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
   2. Shop Drawings shall be prepared by persons with the following qualifications:
      a. Trained and certified by manufacturer in fire-alarm system design.
      b. NICET-certified, fire-alarm technician; Level III minimum.
      c. Licensed or certified Fire Alarm Contractor in the State of Illinois.

B. Product Data: For each type of product, including furnished options and accessories.

C. Shop Drawings: For fire-alarm system.
   1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   2. Include plans, elevations, sections, details, and attachments to other work.
   3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
   4. Detail assembly and support requirements.
   5. Include voltage drop calculations for notification-appliance circuits.
   6. Include battery-size calculations.
   7. Include input/output matrix.
   8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
   9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

11. Include plans, sections, and elevations of heating and ventilating ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
   a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
   b. Show field wiring required for HVAC unit shutdown on alarm.
   c. Locate detectors according to manufacturer's written recommendations.

12. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

13. Drawings shall indicate the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.

14. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.

15. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Data: Certificates, for fire-alarm control unit, accessories, and components, from manufacturer.

C. Field quality-control reports.

D. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
   1. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
   2. Provide "Fire Alarm and Emergency Communications System Record or Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   3. Complete wiring diagrams showing connections between all devices and equipment.
   4. Riser diagram.
   5. Record copy of site-specific software.
   6. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
      a. Equipment tested.
      b. Frequency of testing of installed components.
      c. Frequency of inspection of installed components.
      d. Requirements and recommendations related to results of maintenance.
      e. Manufacturer's user training manuals.
   7. Manufacturer's required maintenance related to system warranty requirements.
   8. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.
B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project. Contractor shall be licensed in the state of Illinois.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

E. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FM Global-approved alarm company.

F. NFPA Certification: Obtain certification according to NFPA 72.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
   1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
   2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL-certified, addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.
E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices:

2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Carbon monoxide detectors.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm and specific initiating device at fire-alarm control unit.
3. Transmit an alarm signal to the remote alarm receiving station (VERIFY).
4. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
5. Record events in the system memory.

C. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, or remote annunciator.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.

D. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit.

2.3 PERFORMANCE REQUIREMENTS

2.4 FIRE-ALARM CONTROL UNIT

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. SimplexGrinnell LP.

B. General Requirements for Fire-Alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.

3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class C.
2. Pathway Survivability: Level 0.

E. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

F. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.

G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

H. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, and trouble signals shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

I. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

2.5 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38.
1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.

2.6 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be four-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
   a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
   b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
   c. Multiple levels of detection sensitivity for each sensor.
   d. Sensitivity levels based on time of day.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

C. Ionization Smoke Detector:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

2.7 CARBON MONOXIDE DETECTORS
A. General: Carbon monoxide detector listed for connection to fire-alarm system.
1. Mounting: Adapter plate for outlet box mounting.
2. Testable by introducing test carbon monoxide into the sensing cell.
3. Detector shall provide alarm contacts and trouble contacts.
4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Comply with UL 2075.
6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.
8. Test button simulates an alarm condition.

2.8 HEAT DETECTORS
A. General Requirements for Heat Detectors: Comply with UL 521.
1. Temperature sensors shall test for and communicate the sensitivity range of the device.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature or a rate of rise.
1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature.
1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.9 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

B. Chimes: Vibrating type.

C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464.

D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

1. Mounting: Wall mounted unless otherwise indicated.
2. Flashing shall be in a temporal pattern, synchronized with other units.

2.10 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to gas detections system controller to initiate hazardous location notification devices.

1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:

1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.
PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

C. Manual Fire-Alarm Boxes:
   1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
   3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

D. Smoke- or Heat-Detector Spacing: Comply with NFPA 72.

E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.

F. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

G. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

I. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.2 PATHWAYS

A. Pathways shall be installed in Rigid Conduit.

B. Junction Boxes shall be painted red enamel, See Section 26 05 53 "Identification for Electrical Systems".

3.3 CONNECTIONS

A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
1. Smoke dampers in air ducts of designated HVAC duct systems.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 “Identification for Electrical Systems”.

B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visual Inspection: Conduct visual inspection prior to testing.
   a. Inspection shall be based on completed record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter.
   b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.


3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test audible appliances for the private operating mode according to manufacturer's written instructions.

5. Test visible appliances for the public operating mode according to manufacturer's written instructions.

6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Input and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.
F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.7 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 46 21
Section II

Contract Forms
Proposal

Project: Main Pump Building HVAC Upgrades
       Capital Project No. 2002

Location: 3333 Kishwaukee Street, Rockford, Illinois

Completion Date: Substantial completion (all HVAC equipment installed and fully functional) shall be September 16, 2020. Final completion shall be October 30, 2020.

Liquidated Damages: $300/calendar day per each completion date deadline

To: Board of Trustees
   Rock River Water Reclamation District
   3501 Kishwaukee Street
   Rockford, IL 61109

From: ____________________________________________________________
      (Individual, Partnership or Corporation, as case may be)

                                    _____________________________________________
      (Address of Individual, Partnership or Corporation)

Gentlemen:

I (We), the undersigned, hereby propose to furnish all materials, equipment, tools, services, labor, and whatever else may be required to construct and place in service the above subject Sanitary Sewer for the Rock River Water Reclamation District all in accordance with the plans and specifications, provided by the Rock River Water Reclamation District. The undersigned also affirms and declares:

1. That I (we), have, examined and am (are) familiar with all the related contract documents and found that they are accurate and complete and are approved by the undersigned.

2. That I (we), have carefully examined the site of the work, and that, from my (our) investigation, has satisfied myself (ourselves) as to the nature and location of the work, the character, quality, and quantity of materials and the kind and extent of equipment and other facilities needed for the performance of the work, the general and local conditions and all difficulties to be encountered, and all other items which may, in any way, effect the work or its performance.

3. That this bid is made without any understanding, agreement or connection with any other person, firm, or corporation making a bid for the same purposes, and is in all respects fair and without collusion or fraud; and that I (we) are not barred from bidding as a result of a bid-rigging or bid-rotating conviction.
4. That accompanying the Proposal is a Bidder's Bond in the amount specified in Article 1, Notice to Bidders, payable to the Board of Trustees of the Rock River Water Reclamation District, which it is agreed, shall be retained as liquidated damages by said Rock River Water Reclamation District if the undersigned fails to execute the Contract in conformity with the contract documents incorporated in the contract documents and furnish bond as specified, within ten (10) days after notification of the award of the contract to the undersigned.

5. The Bidder is of lawful age and that no other person, firm or corporation has any interest in this Proposal or in the Contract proposed to be entered into.

6. The Bidder is not in arrears to the Rock River Water Reclamation District, upon debt or contract, and is not a defaulter, as surety or otherwise, upon any obligation to the Rock River Water Reclamation District.

7. No officer or employee or person whose salary is payable in whole or in part by the District is, shall be or become interested, directly or indirectly as a contracting party, partner, stockholder, surety of otherwise, in this Proposal, or in the performance of the Contract, or in the work to which it is relates, or in any portion of the profits thereof.

8. The Bidder which I represent complies with all applicable requirements of the Americans with Disabilities Act (ADA) and the Occupational Safety and Health Act (OSHA) and that if said bidder is awarded a contract, it will complete all OSHA-required or ADA-required employee and customer training, will make available all required information, and will hold harmless and indemnify the District and the District's representatives.

In regard to participation in an approved Apprenticeship program, upon request, Contractor will be required to provide written proof of participation.

9. The undersigned, as Bidder, declares that he has adopted and promulgated written sexual harassment policies in accordance with Public Act 99-093 and will make this information available upon request.

10. The undersigned, as Bidder, declares he will comply with prevailing wages in accordance with the Illinois Department of Labor Standards. The State of Illinois requires contractors and subcontractors on public works projects (including the Rock River Water Reclamation District) to submit certified payroll records on a monthly basis, along with a statement affirming that such records are true and accurate, that the wages paid to each worker are not less than the required prevailing rate and that the contractor is aware that filing false records is a Class B Misdemeanor. The successful Bidder shall be responsible for verifying the prevailing wages each month and notifying all subcontractors of the appropriate monthly rates. Prevailing wage rates may be found on the Illinois Department of Labor website at www.illinois.gov/idol/Laws-Rules/CONMED/Pages/Rates.aspx.

The certified payroll records must include the name, address, telephone number, social security number, job classification, hourly wages paid in each pay period, the number of hours worked each day, and the starting and ending time of work each day, for every worker employed on the project. Any contractor who fails to submit a certified payroll or knowingly files a false certified payroll is guilty of a Class B Misdemeanor. Certified payroll reports shall be submitted on industry standard forms such as IDOT Statement of Compliance (SBE 348) or other approved equal.
11. The undersigned, as Bidder, declares he will comply with the Federal Drug Free Workplace Act.

12. The undersigned, as Bidder, declares he will comply with Public Act 83-1030 entitled "Steel Products Procurement Act".

13. The undersigned, as Bidder, declares he will comply with Public Act 96-929 (30 ILCS 570) regarding Illinois residents’ employment.

14. The undersigned, as Bidder, declares he will comply with non-discrimination in employment in accordance with the Illinois Fair Employment Practices Commissions Rules & Regulations.

15. The undersigned, as Bidder, declares that he currently participates in an apprenticeship or training program that is registered with the United States Department of Labor’s Bureau of Apprenticeship and Training or other acceptable State of Illinois Department of Labor monitored program.

In submitting this bid, it is understood that the right is reserved by the Rock River Water Reclamation District to reject any and all bids. It is agreed that this bid may not be withdrawn for a period of sixty (60) days from the opening thereof.

The undersigned further declares that he (they) has (have) carefully examined the following items of work and that the cost of all the work to complete this project is given in this Proposal.
Lump Sum Bid Amount

Total Amount of Lump Sum Bid, expressed in figures, for providing all materials, equipment, warranty, and labor to complete this project in conformity with all specifications in this Invitation to Bid.

$______________________________

The undersigned acknowledges that he has received Addendum numbers ______, ______, ______, ______, and realizes that all Addenda are considered part of the Contract.

Date: ____________________________

Bidder: ____________________________
  (Printed Name of Firm) By: ____________________________
  (Authorized Rep’s Signature)

______________________________
  (Printed Street Address) By: ____________________________
  (Printed Authorized Rep’s Name)

______________________________
  (Printed City, State, Zip) By: ____________________________
  (Printed Authorized Rep’s Title)

______________________________
  (Area Code and Phone Number) By: ____________________________
  (Fax Number)

______________________________
  (Authorized Rep’s Email Address)
Fair Employment Practices Affidavit of Compliance

PROJECT: Main Pump Building HVAC Upgrades, Capital Project No. 2002

NOTE: THE BIDDER MUST EXECUTE THIS AFFIDAVIT AND SUBMIT IT WITH ITS SIGNED BID. THE ROCK RIVER WATER RECLAMATION DISTRICT CANNOT ACCEPT ANY BID WHICH DOES NOT CONTAIN THIS AFFIDAVIT

(Name of person making affidavit), being first duly sworn, deposes and says that:

They are: ___________________ of ___________________

(Officer’s Title) (Company Name)

that said company is and “Equal Opportunity Employer” as defined by Section 2000(e) of Chapter 21, Title 42 of the United States Code annotated and Federal Executive Orders #11735 which are incorporated herein by reference;

and that said company will comply with any and all requirements of Title 44 Admin. Code 750. APPENDIX A – Equal Opportunity Clause, Rules and Regulations, Illinois Department of Human Rights, which read as follows:

1. That it will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, marital status, national origin or ancestry, citizen status, age, physical or mental handicap unrelated to ability, sexual orientation, minority status or an unfavorable discharge from military service; and further that it will examine all job classifications to determine if minority persons or women are underutilized and will take appropriate affirmative action to rectify any such underutilization.

2. That, if he or she hires additional employees in order to perform this contract or any portion of this contract, he or she will determine the availability (in accordance with the Department’s Rules and Regulations) of minorities and women in the areas from which he or she may reasonably recruit and he or she will hire for each job classification for which employees are hired in a way that minorities and women are not underutilized.

3. That, in all solicitations or advertisements for employees placed by him or her or on his or her behalf, he or she will state that all applicants will be afforded equal opportunity without discrimination because of race, color, religion, sex, sexual orientation, marital status, national origin or ancestry, citizenship status, age, physical or mental handicap unrelated to ability, sexual orientation, military status or an unfavorable discharge from military service.

4. That he or she will send to each labor organization or representative of workers with which he or she has or is bound by a collective bargaining or other agreement or understanding, a notice advising such labor organization or representative of the contractor’s obligations under the Illinois Human Rights Act and the Department’s Rules and Regulations. If any labor organization or representative fails or refuses to cooperate with the contractor in his or her efforts to comply with such Act and Rules and Regulations, the contractor will promptly so notify the Department and the contracting agency and will recruit employees from other sources when necessary to fulfill its obligations under the contract.

5. That he or she will submit reports as required by the Department’s Rules and Regulations, furnish all relevant information as may from time to time be requested by the Department or the contracting agency, and that he or she will comply with the Illinois Human Rights Act and the Department’s Rules and Regulations.

6. That he or she will permit access to all relevant books, records, accounts and work sites by personnel of the contracting agency and the Department for purposes of investigation to ascertain compliance with the Illinois Human Rights Act and the Department’s Rules and Regulations.

7. That he or she will include verbatim or by reference the provisions of this clause in every subcontract awarded under which any portion of the contract obligations are undertaken or assumed, so that the provisions will be binding upon the subcontractor. In the same manner as with other provisions of this contract, the contractor will be liable for compliance with applicable provisions of this clause by such subcontractors; and further it will promptly notify the contracting agency and the Department in the event any subcontractor fails or refuses to comply with the provisions. In addition, the contractor will not utilize any subcontractor declared by the Illinois Human Rights Commission to be ineligible for contacts or subcontracts with the State of Illinois or any of its political subdivisions or municipal corporations.

(Source: Amended at 32 Ill. Reg. 16484, effective September 23, 2008)"

IL Dept of Human Rights Registration No.: ___________________ Expiration Date: ___________________

Signature

Subscribed and sworn to before me this day of ______, 20_____.

Notary Public
Not to be used for bidding purposes
Bid Bond

KNOW ALL MEN BY THESE PRESENTS, that we:

_________________________________________________ (hereinafter called the Principal) and

___________________________________________________ (hereinafter called the Surety)
a Corporation chartered and existing under the laws of the State of _______________________ with
its principal offices in the City of _____________________ and authorized to do business in the State
of Illinois are held and firmly bound onto the Rock River Water Reclamation District of Winnebago
County, Illinois (District), in the full and just sum of: FIVE PERCENT (5%) OF THE TOTAL
BID PRICE, good lawful money of the United States of America, to be paid upon demand of the
District, to which payment will and truly to be made we bind ourselves, our heirs, executors,
administrators, and assigns, jointly and severally and firmly by these presents.

WHEREAS, the Principal is about to submit, or has submitted to the District, a proposal for
constructing Sanitary Sewers and Appurtenances.

WHEREAS, the Principal desires to file this bond, in accordance with law, to accompany this
Proposal.

NOW THEREFORE, The conditions of this obligation are such that if the Proposal be accepted, the
Principal shall, within ten days after the date of receipt of a written notice of award of Contract,
execute a Contract in accordance with the Proposal and upon the terms, conditions, and prices set
forth therein, in the form and manner required by the District, and execute a sufficient and satisfactory
Contract Performance Bond payable to said District in an amount of one hundred percent (100%) of
the Contract price (including alternates) in form and with security satisfactory to said District, then
this obligation to be void, otherwise to be and remain in full force and virtue in law; and the Surety
shall, upon failure of the Principal to comply with any or all of the foregoing requirements within the
time specified above, immediately pay to the aforesaid District, upon demand, the amount hereof in
good and lawful money of the United States of America, not as a penalty, but as liquidated damages.
IN TESTIMONY THEREOF, the Principal and Surety have caused these presents to be duly signed and sealed this _____ day of ______________________, 20______.

Principal

(Seal)

By _______________________________
Name: ___________________________
Title: ___________________________
Date: ___________________________

Attest:
_______________________________
Secretary

Surety

(Seal)

By _______________________________
Name: ___________________________
Title: ___________________________
Date: ___________________________
**Agreement**

1. **General**
   
   THIS AGREEMENT, made and concluded this ___ day of ______________, 2020, between the Rock River Water Reclamation District (District), Rockford, Illinois, acting by and through the Board of Trustees, and ____________________, his/her executors, administrators, successors or assigns:

2. **Scope of Work**
   
   WITNESSETH: That for and in consideration of the payments and agreements made in the Proposal attached hereto, to be made and performed by the District and according to the terms expressed in the Bond referring to these presents, the Contractor agrees with the District at his/her own proper cost and expense to do all the work, furnish all equipment, materials and all labor necessary to complete the work in accordance with the plans and specifications hereinafter described, and in full compliance with all of the terms of this agreement and the requirements of the District and its representative.

   And it is also understood and agreed that the Bidding Requirements, Detailed Specifications, Contract Forms, General Conditions, General Requirements, Technical Specifications, Plans, Addenda, and provisions required by law are all essential documents of the contract, and are a part hereof, as if herein set out verbatim or as if attached, except for titles, subtitles, headings, table of contents and portions specifically excluded.

3. **Contract Price**
   
   The District shall pay to the Contractor, and the Contractor shall accept, in full payment for the performance of this Contract, subject to any additions or deductions provided for hereby, in current funds, the Total Contract Price of ___________________________ and 00/100 ($____________________).

   Payments are to be made to the Contractor in accordance with and subject to the provisions of Section 7 of this Agreement, which is a part of this Contract.

4. **Bond**
   
   The Contractor has entered into and herewith tenders a bond of even date herewith, in the penal sum of ___________________________ and 00/100 ($____________________) to insure the faithful performance of this Contract, which said bond is hereby made a part of this Contract by reference.

5. **Maintenance and Guarantee**
   
   The Contractor shall promptly repair, replace, restore or rebuild any imperfections that may arise and shall maintain satisfactory to the District all work for a period three (3) years from the date of final acceptance of the Contract for trench settlement and for a period of two (2) years all other work, except where periods of maintenance and guarantee are provided for. The Contractor shall, for this period, indemnify and save harmless the District, its officers and agents from any injury done to
property or persons as a direct or alleged result of imperfections in the Contractors’ work, and shall immediately assume and take charge of the defense of such action or suits in like manner and to all intents and purposes as if said actions and suits had been brought directly against the Contractor.

If the Contractor shall fail to repair, replace, rebuild or restore such defective or damaged work promptly after receiving notice given by the District, the District shall have the right to have the work done by others and to call on the Contractor and his bondsman to pay the costs thereof.

6. Contract Execution

IT IS EXPRESSLY UNDERSTOOD AND AGREED that the entire improvement shall be done in a thorough and workmanlike manner, under the direction and to the satisfaction of the District and in full compliance with all the requirements of its representative under them. All loss or damage arising out of the nature of the work to be done, or from any detention of unforeseen obstruction or difficulty which may be encountered in the prosecution of the work, or from the action of the elements, shall be sustained by the Contractor.

The Contractor will be held responsible for all accidents, and hereby agrees to indemnify and protect the District from all suits, claims, and actions brought against it, and all cost, and damages which the District may be put to by reason of an injury or alleged injury, to the person or property of another in the execution of this contract, or the performance of the work, or in guarding the same, or for any material used in its prosecution or in its construction.

Any person employed on the work who shall refuse or neglect to obey the directions of the District or its representative, or who shall be deemed by the District to be incompetent, or who shall commit any disorderly conduct, or who shall be guilty of any trespass on any public or private property in the vicinity of the work, shall at once be removed from the work by the Contractor when so requested by the District.

Any request to extend the contract completion date must be considered by the Board at the Board meeting prior to the then-existing contract termination date. Any deviation from this action will result in the liquidated damage clause in the contract to be exercised.

7. Payments to Contractor

The District hereby covenants and agrees, in consideration of the covenants and agreements in this Contract, specified to be kept and performed by the Contractor and subject to the conditions herein contained, and if the District receives an acceptable invoice prior to the tenth day of the month and receives approval of the work by the District Engineering Manager, the District shall issue payment before the fifth day of the succeeding month. If the District receives an acceptable invoice on or after the tenth day of the month, the District shall issue payment before the fifth day of the second succeeding month.

The District reserves the right at all times to refuse to issue payment in case the Contractor has neglected or failed to pay any subcontractors, workmen or employee on the work.
8. **Subcontracts**

No part of the work herein provided for shall be sublet or subcontracted without the express consent of the District, to be entered in the records, and in no case shall consent relieve the Contractor from the obligation herein entered into, or change the terms of this Agreement.

9. **Contractor's Responsibility**

This Contract shall extend to and be binding upon the successors and assigns, and upon the heirs, administrators, executors, and legal representatives of the Contractor.

In consideration of and to induce the award of this Contract to him, the Contractor represents and warrants: that he is not in arrears to the District upon debt of the Contract and that he is not a defaulter, as surety, contractor or otherwise; that he is financially solvent and sufficiently experienced and competent to perform the work; that the work can be performed as called for by the Contract; that the facts stated in his proposal and the information given by him is true and correct in all respects, and that he is fully informed regarding all the conditions affecting the work to be done and labor and materials to be furnished for the completion of this Contract and that his information was secured by personal investigation and research.

The Contractor shall pay not less than the prevailing wage rate as determined by the Department of Labor, to all laborers, workmen and mechanics performing work under this Contract. Contractor shall comply with current revisions of the wage standards; as required by law. The Contractor shall be responsible for verifying the prevailing wages each month and notifying all subcontractors of the appropriate monthly rates. Certified payroll reports shall be submitted on industry standard forms such as IDOT Statement of Compliance (Form SBE 348).

In regard to nondiscrimination in employment, Contractor will be required to comply with the Illinois Fair Employment Practices Commission's Rules and Regulations as provided herein.

The Contractor shall comply with the American Disabilities Act of 1990 (ADA). The Contractor will hold harmless and indemnify the District and their representatives from all:

- suits, claims, or actions;
- costs, either for defense (including but not limited to reasonable attorney's fees and expert witness fees) or for settlement, and;
- damages of any kind (including but not limited to actual, punitive, and compensatory damages)

relating in any way to or arising out of the ADA, to which said firm is exposed or which it incurs in the execution of the contract.

Contractor shall also comply with Public Act 99-0933, which requires any party to a contract to adopt and enforce a written policy regarding sexual harassment that includes, as a minimum, the following information:

- the illegality of sexual harassment
- the definition of sexual harassment under Illinois State law;
- a description of sexual harassment, utilizing examples;
- my (our) organization's internal complaint process including penalties;
(f) directions on how to contact the Department and the Commission; and
(g) protection against retaliation as provided by Section 6-101 of the Illinois Human Rights Act.

Upon request this information will be provided to the Illinois Department of Human Rights. Upon District award of a contract, the District will be provided this information described no more than ten working days after the District issues its award notification.

The Contractor shall comply with Article 2 of Public Act 83-1472 which provides that Illinois residents be employed on Illinois public works projects, provided there has been a period of excessive unemployment (5%) in the State of Illinois as defined in the Act; and further, that Illinois workers are available and capable of performing the particular type work involved.

The Contractor shall comply with all rules and regulations of OSHA during the execution of this Contract.

The Contractor shall comply with the Federal Drug Free Workplace Act.

The Steel Products Procurement Act, Illinois Public Act 83-1030, requires that steel products used or supplied in performance of this Contract or subcontract shall be manufactured or produced in the United States with three exceptions, as explained in the Instructions to Bidders.

The Contractor shall comply with Public Act 96-1416 regarding the disposal of CCDD and uncontaminated soil at CCDD fill sites as explained in the Instructions to Bidders.

10. Time

Work under this Agreement shall be commenced upon written Notice to Proceed. Substantial completion (all HVAC equipment installed and fully functional) shall be September 16, 2020. Final completion shall be October 30, 2020.

11. Liquidated Damages

The amount of liquidated damages shall be $300.00 per calendar day per each consecutive calendar day for each completion date.

12. Counterparts

This Agreement may be executed and recorded in counterparts, each of which shall be deemed an original and all of which, when taken together, shall constitute one and the same instrument. The Parties hereby acknowledge and agree that facsimile signatures or signatures transmitted by electronic mail in so-called “pdf” format shall be legal and binding and shall have the same full force and effect as if an original of this Agreement had been delivered. Each of the parties (a) intend to be bound by the signatures on any document sent by facsimile or electronic mail, (b) are aware that the other party will rely on such signatures, and (c) hereby waive any defenses to the enforcement of the terms of this Agreement based on the foregoing forms of signature.
13. **Seals**

IN WITNESS WHEREOF, the parties have hereunto set their hands and seals, and such of them as are corporations have caused these presents to be signed by their duly authorized officers.

Rock River Water Reclamation District  
Winnebago County, Illinois

(Seal)

By __________________________________________  
President, Board of Trustees

ATTEST: __________________________________________  
Clerk of the Board

**Contractor**

By __________________________________________  
Contractor’s Officer

(Corporate Seal)

Name: __________________________________________
Title: __________________________________________
Date: __________________________________________

ATTEST: __________________________________________
Not to be used for bidding purposes
Performance Bond

KNOW ALL MEN BY THESE PRESENTS, that WHEREAS, the Rock River Water Reclamation District has awarded to: ___________________________________________, hereinafter designated as the “Principal”, a contract, dated, ________________, for the Rock River Water Reclamation District.

WHEREAS, said Principal is required under the terms of said Contract to furnish a bond for the faithful performance of said Contract (the “Bond”);

NOW, THEREFORE, we the Principal and __________________________________________, as Surety, are firmly bound unto the Rock River Water Reclamation District in the penal sum of __________________________________________ Dollars ($____________________ ) lawful money of the United States for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally firmly by these presents for a performance bond. The conditions of this obligation is such that if the said Principal does well and faithfully performs all the conditions and covenants of said Contract, according to the true intent and meaning thereof, upon its part to be kept and performed, then the above obligation is to be null and void, otherwise to remain in full force and effect.

THE CONDITION OF THIS OBLIGATION IS SUCH, that if the above bounden Principal, its heirs, executors, administrators, successors or assigns, shall in all things stand to and abide by, and well and truly keep and perform the covenants, conditions and agreements in the said Contract, including the provisions for liquidated damages in the said Contract, any changes, additions or alterations thereof made as therein provided, on its part, to be kept and performed at the time and in the manner therein specified, and in all respects according to their true intent and meaning, and shall indemnify and save harmless the Rock River Water Reclamation District, its officers and agents, as therein stipulated, then this obligation shall become null and void; otherwise it shall be and remain in full force and effect. And the said Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the work to be performed thereunder or the specifications accompanying the same and no inadvertent overpayment of progress payments shall in any way affect its obligations on this Bond, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the Contract or to the work or to the specifications or of any inadvertent overpayment of progress payments. The Rock River Water Reclamation District shall be named as beneficiary on this Performance Bond.
IN WITNESS WHEREOF, the above-bounden parties have executed this instrument under their seal this _____ day of _______________, 20____, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

CONTRACTOR

Contractor Firm Name

By: _____________________________

Signature

Printed Name

Title

ATTEST:

Corporate Secretary (Corporations only)

SURETY

By: _____________________________

Attorney-in-Fact Signature

Printed Name

Resident Agent
Labor & Material Payment Bond

TO: ____________________________ Contractor Name

___________________________ Contractor City, State

KNOW ALL MEN BY THESE PRESENTS

That ____________________________ (Contractor)

as Principal, and ____________________________

a corporation of the State of ____________________________ as Surety, are held and firmly bound unto
the Rock River Water Reclamation District, as Obligee, for the use and benefit of claimants as
hereinafter defined in the amount of

__________________________ Dollars ($__________), for the payment

where of Principal and Surety bind themselves, their heirs, executors, administrators, successors and
assigns, jointly and severally, firmly by these presents.

WHEREAS, Principal has by written agreement dated ______ 20__ Entered into a Contract
with Obligee for ____________________________ in accordance with contract
documents prepared by the Rock River Water Reclamation District which Contract is by reference
made a part hereof, and is hereinafter referred to as “the Contract”.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that if
Principal shall promptly pay for all laborers, workers and mechanics engaged in the work under the
Contract, and not less than the general prevailing rate of hourly wages of a similar character in the
locality in which the work is performed, as determined by the State of Illinois Department of Labor
pursuant to the Illinois Compiled Statutes 280 ILCS 130 / 1-12 et.seq. and for all material used or
reasonably required for use in the performance of the Contract, then this obligation shall be void;
otherwise it shall remain in full force and effect.

1. A claimant is deemed as any person, firm, or corporation having contracts with the Principal
or with any of Principal’s subcontractors for labor or materials furnished in the performance
of the Contract on account of which this Bond is given.

2. Nothing in this Bond contained shall be taken to make the Obligee liable to any subcontractor,
material man or laborer, or to any other person to any greater extent than it would have been
liable prior to the enactment of The Public Construction Bond Act, approved June 20, 1931,
as amended; provided further, that any person having a claim for labor and materials furnished
in the performance of the Contract shall have no right of action unless he shall have filed a
verified notice of such claim with the Obligee within 180 days after the date of the last item
of work or the furnishing of the last item of materials, which claim shall have been verified
and shall contain the name and address of the claimant, the business address of the claimant
within the State of Illinois, if any, or if the claimant be a foreign corporation having no place

Not to be used for bidding purposes
of business within the State the principal place of business of the corporation, and in all cases
of partnership the names and residences of each of the partners, the name of the Contractor
for the Obligee, the name of the person, firm or corporation by whom the claimant was
employed or to whom such claimant furnished materials, the amount of the claim and a brief
description of the public improvement for the construction or installation of which the contract
is to be performed. No defect in the notice herein provided for shall deprive the claimant of
its right of action under the terms and provisions of this Bond unless it shall affirmatively
appear that such defect has prejudiced the rights of an interested party asserting the same.

3. No action shall be brought on this Bond until the expiration of 120 days after the date of the
last item of work or of the furnishing of the last item of material except in cases where the
final settlement between Obligee and the Contractor shall have been made prior to the
expiration of the 120 day period, in which case action may be taken immediately following
such final settlement; nor shall any action of any kind be brought later than 6 months after the
acceptance by the Obligee of the work. Such suit shall be brought only in the circuit court of
this State in the judicial district in which the Contract is to be performed.

4. Surety hereby waives notice of any changes in the Contract, including extensions of time for
the performance thereof.

5. The amount of this Bond shall be reduced by and to the extent of any payment or payments
made in good faith hereunder.

6. The Principal and Surety shall be liable for any attorneys’ fees, engineering costs, or court
costs incurred by the Obligee relative to claims made against this Bond.

Signed and Sealed this __________ day of ________________________, 20____.

CONTRACTOR SURETY

________________________________________________________
Contractor Firm Name

By: ________________________________ By: ________________________________
   Signature                         Attorney-in-Fact Signature

______________________________ ________________________________
Printed Name                   Printed Name

______________________________
Title

Resident Agent

ATTEST:

________________________________________________________
Corporate Secretary (Corporations only)
Section III

EJ CDC C-700 General Conditions and Supplementary Conditions
# STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Article</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Definitions and Terminology</td>
<td>4</td>
</tr>
<tr>
<td>1.01</td>
<td>Defined Terms</td>
<td>4</td>
</tr>
<tr>
<td>1.02</td>
<td>Terminology</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Preliminary Matters</td>
<td>7</td>
</tr>
<tr>
<td>2.01</td>
<td>Delivery of Bonds and Evidence of Insurance</td>
<td>7</td>
</tr>
<tr>
<td>2.02</td>
<td>Copies of Documents</td>
<td>7</td>
</tr>
<tr>
<td>2.03</td>
<td>Commencement of Contract Times; Notice to Proceed</td>
<td>7</td>
</tr>
<tr>
<td>2.04</td>
<td>Starting the Work</td>
<td>7</td>
</tr>
<tr>
<td>2.05</td>
<td>Before Starting Construction</td>
<td>8</td>
</tr>
<tr>
<td>2.06</td>
<td>Preconstruction Conference; Designation of Authorized Representatives</td>
<td>8</td>
</tr>
<tr>
<td>2.07</td>
<td>Initial Acceptance of Schedules</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Contract Documents: Intent, Amending, Reuse</td>
<td>9</td>
</tr>
<tr>
<td>3.01</td>
<td>Intent</td>
<td>9</td>
</tr>
<tr>
<td>3.02</td>
<td>Reference Standards</td>
<td>9</td>
</tr>
<tr>
<td>3.03</td>
<td>Reporting and Resolving Discrepancies</td>
<td>9</td>
</tr>
<tr>
<td>3.04</td>
<td>Amending and Supplementing Contract Documents</td>
<td>10</td>
</tr>
<tr>
<td>3.05</td>
<td>Reuse of Documents</td>
<td>10</td>
</tr>
<tr>
<td>3.06</td>
<td>Electronic Data</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>Availability of Lands; Subsurface and Physical Conditions; Hazardous Environmental Conditions; Reference Points</td>
<td>11</td>
</tr>
<tr>
<td>4.01</td>
<td>Availability of Lands</td>
<td>11</td>
</tr>
<tr>
<td>4.02</td>
<td>Subsurface and Physical Conditions</td>
<td>12</td>
</tr>
<tr>
<td>4.03</td>
<td>Differing Subsurface or Physical Conditions</td>
<td>12</td>
</tr>
<tr>
<td>4.04</td>
<td>Underground Facilities</td>
<td>14</td>
</tr>
<tr>
<td>4.05</td>
<td>Reference Points</td>
<td>15</td>
</tr>
<tr>
<td>4.06</td>
<td>Hazardous Environmental Condition at Site</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>Bonds and Insurance</td>
<td>17</td>
</tr>
<tr>
<td>5.01</td>
<td>Performance, Payment, and Other Bonds</td>
<td>17</td>
</tr>
<tr>
<td>5.02</td>
<td>Licensed Sureties and Insurers</td>
<td>17</td>
</tr>
<tr>
<td>5.03</td>
<td>Certificates of Insurance</td>
<td>17</td>
</tr>
<tr>
<td>5.04</td>
<td>Contractor’s Insurance</td>
<td>18</td>
</tr>
<tr>
<td>5.05</td>
<td>Owner’s Liability Insurance</td>
<td>19</td>
</tr>
<tr>
<td>5.06</td>
<td>Property Insurance</td>
<td>19</td>
</tr>
<tr>
<td>5.07</td>
<td>Waiver of Rights</td>
<td>21</td>
</tr>
<tr>
<td>5.08</td>
<td>Receipt and Application of Insurance Proceeds</td>
<td>22</td>
</tr>
<tr>
<td>5.09</td>
<td>Acceptance of Bonds and Insurance; Option to Replace</td>
<td>22</td>
</tr>
<tr>
<td>5.10</td>
<td>Partial Utilization, Acknowledgment of Property Insurer</td>
<td>22</td>
</tr>
<tr>
<td>Article 6 – Contractor’s Responsibilities</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>6.01 Supervision and Superintendence</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>6.02 Labor; Working Hours</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>6.03 Services, Materials, and Equipment</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>6.04 Progress Schedule</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>6.05 Substitutes and “Or-Equals”</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>6.06 Concerning Subcontractors, Suppliers, and Others</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>6.07 Patent Fees and Royalties</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>6.08 Permits</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>6.09 Laws and Regulations</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>6.10 Taxes</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>6.11 Use of Site and Other Areas</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>6.12 Record Documents</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>6.13 Safety and Protection</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>6.14 Safety Representative</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>6.15 Hazard Communication Programs</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>6.16 Emergencies</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>6.17 Shop Drawings and Samples</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>6.18 Continuing the Work</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>6.19 Contractor’s General Warranty and Guarantee</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>6.20 Indemnification</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>6.21 Delegation of Professional Design Services</td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Article 7 – Other Work at the Site</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.01 Related Work at Site</td>
<td>35</td>
</tr>
<tr>
<td>7.02 Coordination</td>
<td>36</td>
</tr>
<tr>
<td>7.03 Legal Relationships</td>
<td>36</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Article 8 – Owner’s Responsibilities</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.01 Communications to Contractor</td>
<td>37</td>
</tr>
<tr>
<td>8.02 Replacement of Engineer</td>
<td>37</td>
</tr>
<tr>
<td>8.03 Furnish Data</td>
<td>37</td>
</tr>
<tr>
<td>8.04 Pay When Due</td>
<td>37</td>
</tr>
<tr>
<td>8.05 Lands and Easements; Reports and Tests</td>
<td>37</td>
</tr>
<tr>
<td>8.06 Insurance</td>
<td>37</td>
</tr>
<tr>
<td>8.07 Change Orders</td>
<td>37</td>
</tr>
<tr>
<td>8.08 Inspections, Tests, and Approvals</td>
<td>37</td>
</tr>
<tr>
<td>8.09 Limitations on Owner’s Responsibilities</td>
<td>37</td>
</tr>
<tr>
<td>8.10 Undisclosed Hazardous Environmental Condition</td>
<td>38</td>
</tr>
<tr>
<td>8.11 Evidence of Financial Arrangements</td>
<td>38</td>
</tr>
<tr>
<td>8.12 Compliance with Safety Program</td>
<td>38</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Article 9 – Engineer’s Status During Construction</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.01 Owner’s Representative</td>
<td>38</td>
</tr>
<tr>
<td>9.02 Visits to Site</td>
<td>38</td>
</tr>
<tr>
<td>9.03 Project Representative</td>
<td>39</td>
</tr>
<tr>
<td>9.04 Authorized Variations in Work</td>
<td>39</td>
</tr>
<tr>
<td>9.05 Rejecting Defective Work</td>
<td>39</td>
</tr>
<tr>
<td>9.06 Shop Drawings, Change Orders and Payments</td>
<td>39</td>
</tr>
<tr>
<td>Article</td>
<td>Section</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Article 9</td>
<td>9.07 Determinations for Unit Price Work</td>
</tr>
<tr>
<td></td>
<td>9.08 Decisions on Requirements of Contract Documents and Acceptability of Work</td>
</tr>
<tr>
<td></td>
<td>9.09 Limitations on Engineer’s Authority and Responsibilities</td>
</tr>
<tr>
<td></td>
<td>9.10 Compliance with Safety Program</td>
</tr>
<tr>
<td>Article 10</td>
<td>10.01 Authorized Changes in the Work</td>
</tr>
<tr>
<td></td>
<td>10.02 Unauthorized Changes in the Work</td>
</tr>
<tr>
<td></td>
<td>10.03 Execution of Change Orders</td>
</tr>
<tr>
<td></td>
<td>10.04 Notification to Surety</td>
</tr>
<tr>
<td></td>
<td>10.05 Claims</td>
</tr>
<tr>
<td>Article 11</td>
<td>11.01 Cost of the Work</td>
</tr>
<tr>
<td></td>
<td>11.02 Allowances</td>
</tr>
<tr>
<td></td>
<td>11.03 Unit Price Work</td>
</tr>
<tr>
<td>Article 12</td>
<td>12.01 Change of Contract Price</td>
</tr>
<tr>
<td></td>
<td>12.02 Change of Contract Times</td>
</tr>
<tr>
<td></td>
<td>12.03 Delays</td>
</tr>
<tr>
<td>Article 13</td>
<td>13.01 Notice of Defects</td>
</tr>
<tr>
<td></td>
<td>13.02 Access to Work</td>
</tr>
<tr>
<td></td>
<td>13.03 Tests and Inspections</td>
</tr>
<tr>
<td></td>
<td>13.04 Uncovering Work</td>
</tr>
<tr>
<td></td>
<td>13.05 Owner May Stop the Work</td>
</tr>
<tr>
<td></td>
<td>13.06 Correction or Removal of Defective Work</td>
</tr>
<tr>
<td></td>
<td>13.07 Correction Period</td>
</tr>
<tr>
<td></td>
<td>13.08 Acceptance of Defective Work</td>
</tr>
<tr>
<td></td>
<td>13.09 Owner May Correct Defective Work</td>
</tr>
<tr>
<td>Article 14</td>
<td>14.01 Schedule of Values</td>
</tr>
<tr>
<td></td>
<td>14.02 Progress Payments</td>
</tr>
<tr>
<td></td>
<td>14.03 Contractor’s Warranty of Title</td>
</tr>
<tr>
<td></td>
<td>14.04 Substantial Completion</td>
</tr>
<tr>
<td></td>
<td>14.05 Partial Utilization</td>
</tr>
<tr>
<td></td>
<td>14.06 Final Inspection</td>
</tr>
<tr>
<td></td>
<td>14.07 Final Payment</td>
</tr>
<tr>
<td></td>
<td>14.08 Final Completion Delayed</td>
</tr>
<tr>
<td></td>
<td>14.09 Waiver of Claims</td>
</tr>
<tr>
<td>Article 15</td>
<td>15.01 Owner May Suspend Work</td>
</tr>
<tr>
<td></td>
<td>15.02 Owner May Terminate for Cause</td>
</tr>
<tr>
<td></td>
<td>15.03 Owner May Terminate For Convenience</td>
</tr>
<tr>
<td></td>
<td>15.04 Contractor May Stop Work or Terminate</td>
</tr>
</tbody>
</table>
DEFINITIONS AND TERMINOLOGY

1.01  Defined Terms

A. Wherever used in the Bidding Requirements or Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated which are applicable to
both the singular and plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. **Addenda**—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.

2. **Agreement**—The written instrument which is evidence of the agreement between Owner and Contractor covering the Work.

3. **Application for Payment**—The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

4. **Asbestos**—Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.

5. **Bid**—The offer or proposal of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

6. **Bidder**—The individual or entity who submits a Bid directly to Owner.

7. **Bidding Documents**—The Bidding Requirements and the proposed Contract Documents (including all Addenda).

8. **Bidding Requirements**—The advertisement or invitation to bid, Instructions to Bidders, Bid security of acceptable form, if any, and the Bid Form with any supplements.

9. **Change Order**—A document recommended by Engineer which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.

10. **Claim**—A demand or assertion by Owner or Contractor seeking an adjustment of Contract Price or Contract Times, or both, or other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.

11. **Contract**—The entire and integrated written agreement between the Owner and Contractor concerning the Work. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

12. **Contract Documents**—Those items so designated in the Agreement. Only printed or hard copies of the items listed in the Agreement are Contract Documents. Approved Shop Drawings, other Contractor submittals, and the reports and drawings of subsurface and physical conditions are not Contract Documents.
13. **Contract Price**—The moneys payable by Owner to Contractor for completion of the Work in accordance with the Contract Documents as stated in the Agreement (subject to the provisions of Paragraph 11.03 in the case of Unit Price Work).

14. **Contract Times**—The number of days or the dates stated in the Agreement to: (i) achieve Milestones, if any; (ii) achieve Substantial Completion; and (iii) complete the Work so that it is ready for final payment as evidenced by Engineer’s written recommendation of final payment.

15. **Contractor**—The individual or entity with whom Owner has entered into the Agreement.

16. **Cost of the Work**—See Paragraph 11.01 for definition.

17. **Drawings**—That part of the Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Work to be performed by Contractor. Shop Drawings and other Contractor submittals are not Drawings as so defined.

18. **Effective Date of the Agreement**—The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.

19. **Engineer**—The individual or entity named as such in the Agreement.

20. **Field Order**—A written order issued by Engineer which requires minor changes in the Work but which does not involve a change in the Contract Price or the Contract Times.

21. **General Requirements**—Sections of Division 1 of the Specifications.

22. **Hazardous Environmental Condition**—The presence at the Site of Asbestos, PCBs, Petroleum, Hazardous Waste, or Radioactive Material in such quantities or circumstances that may present a substantial danger to persons or property exposed thereto.

23. **Hazardous Waste**—The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.

24. **Laws and Regulations; Laws or Regulations**—Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

25. **Liens**—Charges, security interests, or encumbrances upon Project funds, real property, or personal property.

26. **Milestone**—A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.

27. **Notice of Award**—The written notice by Owner to the Successful Bidder stating that upon timely compliance by the Successful Bidder with the conditions precedent listed therein, Owner will sign and deliver the Agreement.
28. **Notice to Proceed**—A written notice given by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work under the Contract Documents.

29. **Owner**—The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed.

30. **PCBs**—Polychlorinated biphenyls.

31. **Petroleum**—Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Waste and crude oils.

32. **Progress Schedule**—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor’s plan to accomplish the Work within the Contract Times.

33. **Project**—The total construction of which the Work to be performed under the Contract Documents may be the whole, or a part.

34. **Project Manual**—The bound documentary information prepared for bidding and constructing the Work. A listing of the contents of the Project Manual, which may be bound in one or more volumes, is contained in the table(s) of contents.

35. **Radioactive Material**—Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.

36. **Resident Project Representative**—The authorized representative of Engineer who may be assigned to the Site or any part thereof.

37. **Samples**—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

38. **Schedule of Submittals**—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements to support scheduled performance of related construction activities.

39. **Schedule of Values**—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor’s Applications for Payment.

40. **Shop Drawings**—All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.

41. **Site**—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements for access.
thereo, and such other lands furnished by Owner which are designated for the use of Contractor.

42. Specifications—That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable thereto.

43. Subcontractor—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the Site.

44. Substantial Completion—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms “substantially complete” and “substantially completed” as applied to all or part of the Work refer to Substantial Completion thereof.

45. Successful Bidder—The Bidder submitting a responsive Bid to whom Owner makes an award.

46. Supplementary Conditions—That part of the Contract Documents which amends or supplements these General Conditions.

47. Supplier—A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or Subcontractor.

48. Underground Facilities—All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.

49. Unit Price Work—Work to be paid for on the basis of unit prices.

50. Work—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction, and furnishing, installing, and incorporating all materials and equipment into such construction, all as required by the Contract Documents.

51. Work Change Directive—A written statement to Contractor issued on or after the Effective Date of the Agreement and signed by Owner and recommended by Engineer ordering an addition, deletion, or revision in the Work, or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed or to emergencies. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order.
following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

1.02 Terminology

A. The words and terms discussed in Paragraph 1.02.B through F are not defined but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. Intent of Certain Terms or Adjectives:

1. The Contract Documents include the terms “as allowed,” “as approved,” “as ordered,” “as directed” or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.09 or any other provision of the Contract Documents.

C. Day:

1. The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.

D. Defective:

1. The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:

a. does not conform to the Contract Documents; or

b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or

c. has been damaged prior to Engineer’s recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 14.04 or 14.05).

E. Furnish, Install, Perform, Provide:

1. The word “furnish,” when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.
2. The word “install,” when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.

4. When “furnish,” “install,” “perform,” or “provide” is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, “provide” is implied.

F. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 – PRELIMINARY MATTERS

2.01 Delivery of Bonds and Evidence of Insurance

A. When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.

B. Evidence of Insurance: Before any Work at the Site is started, Contractor and Owner shall each deliver to the other, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which either of them or any additional insured may reasonably request) which Contractor and Owner respectively are required to purchase and maintain in accordance with Article 5.

2.02 Copies of Documents

A. Owner shall furnish to Contractor up to ten printed or hard copies of the Drawings and Project Manual. Additional copies will be furnished upon request at the cost of reproduction.

2.03 Commencement of Contract Times; Notice to Proceed

A. The Contract Times will commence to run on the thirtieth day after the Effective Date of the Agreement or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Agreement. In no event will the Contract Times commence to run later than the sixtieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Agreement, whichever date is earlier.

2.04 Starting the Work

A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work shall be done at the Site prior to the date on which the Contract Times commence to run.
2.05 Before Starting Construction

A. Preliminary Schedules: Within 10 days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), Contractor shall submit to Engineer for timely review:

1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract Documents;

2. a preliminary Schedule of Submittals; and

3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.06 Preconstruction Conference; Designation of Authorized Representatives

A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.05.A, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, and maintaining required records.

B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit instructions, receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.07 Initial Acceptance of Schedules

A. At least 10 days before submission of the first Application for Payment a conference attended by Contractor, Engineer, and others as appropriate will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.05.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to Contractor until acceptable schedules are submitted to Engineer.

1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor’s full responsibility therefor.

2. Contractor’s Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.
3. Contractor’s Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to component parts of the Work.

ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

3.01 Intent

A. The Contract Documents are complementary; what is required by one is as binding as if required by all.

B. It is the intent of the Contract Documents to describe a functionally complete project (or part thereof) to be constructed in accordance with the Contract Documents. Any labor, documentation, services, materials, or equipment that reasonably may be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the indicated result will be provided whether or not specifically called for, at no additional cost to Owner.

C. Clarifications and interpretations of the Contract Documents shall be issued by Engineer as provided in Article 9.

3.02 Reference Standards

A. Standards, Specifications, Codes, Laws, and Regulations

1. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard, specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

2. No provision of any such standard, specification, manual, or code, or any instruction of a Supplier, shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees, from those set forth in the Contract Documents. No such provision or instruction shall be effective to assign to Owner, Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.03 Reporting and Resolving Discrepancies

A. Reporting Discrepancies:

1. Contractor’s Review of Contract Documents Before Starting Work: Before undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy which Contractor discovers, or has actual knowledge of, and shall obtain a written
interpretation or clarification from Engineer before proceeding with any Work affected thereby.

2. **Contractor’s Review of Contract Documents During Performance of Work**: If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) any standard, specification, manual, or code, or (c) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 6.16.A) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.04.

3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. **Resolving Discrepancies**:

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Contract Documents and:

   a. the provisions of any standard, specification, manual, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference in the Contract Documents); or

   b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

**3.04 Amending and Supplementing Contract Documents**

A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof by either a Change Order or a Work Change Directive.

B. The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, by one or more of the following ways:

1. A Field Order;

2. Engineer’s approval of a Shop Drawing or Sample (subject to the provisions of Paragraph 6.17.D.3); or

3. Engineer’s written interpretation or clarification.

**3.05 Reuse of Documents**

A. Contractor and any Subcontractor or Supplier shall not:
1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media editions; or

2. reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer.

B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

3.06 Electronic Data

A. Unless otherwise stated in the Supplementary Conditions, the data furnished by Owner or Engineer to Contractor, or by Contractor to Owner or Engineer, that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user’s sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.

B. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data’s creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the data thus transferred. Any errors detected within the 60-day acceptance period will be corrected by the transferring party.

C. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data’s creator.

ARTICLE 4 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS; REFERENCE POINTS

4.01 Availability of Lands

A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work. Owner will obtain in a timely manner and pay for easements for permanent structures or permanent changes in existing facilities. If Contractor and Owner are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, as a result of any delay in Owner’s furnishing the Site or a part thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which the Work is to be performed and
Owner’s interest therein as necessary for giving notice of or filing a mechanic’s or construction lien against such lands in accordance with applicable Laws and Regulations.

C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.02 Subsurface and Physical Conditions

A. Reports and Drawings: The Supplementary Conditions identify:

1. those reports known to Owner of explorations and tests of subsurface conditions at or contiguous to the Site; and

2. those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities).

B. Limited Reliance by Contractor on Technical Data Authorized: Contractor may rely upon the accuracy of the “technical data” contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such “technical data” is identified in the Supplementary Conditions. Except for such reliance on such “technical data,” Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:

1. the completeness of such reports and drawings for Contractor’s purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any “technical data” or any such other data, interpretations, opinions, or information.

4.03 Differing Subsurface or Physical Conditions

A. Notice: If Contractor believes that any subsurface or physical condition that is uncovered or revealed either:

1. is of such a nature as to establish that any “technical data” on which Contractor is entitled to rely as provided in Paragraph 4.02 is materially inaccurate; or

2. is of such a nature as to require a change in the Contract Documents; or

3. differs materially from that shown or indicated in the Contract Documents; or

4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;
then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

B. *Engineer’s Review:* After receipt of written notice as required by Paragraph 4.03.A, Engineer will promptly review the pertinent condition, determine the necessity of Owner’s obtaining additional exploration or tests with respect thereto, and advise Owner in writing (with a copy to Contractor) of Engineer’s findings and conclusions.

C. *Possible Price and Times Adjustments:*

1. The Contract Price or the Contract Times, or both, will be equitably adjusted to the extent that the existence of such differing subsurface or physical condition causes an increase or decrease in Contractor’s cost of, or time required for, performance of the Work; subject, however, to the following:
   a. such condition must meet any one or more of the categories described in Paragraph 4.03.A; and
   b. with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.07 and 11.03.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times if:
   a. Contractor knew of the existence of such conditions at the time Contractor made a final commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract; or
   b. the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor’s making such final commitment; or
   c. Contractor failed to give the written notice as required by Paragraph 4.03.A.

3. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, a Claim may be made therefor as provided in Paragraph 10.05. However, neither Owner nor Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors shall be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.
4.04 Underground Facilities

A. Shown or Indicated: The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

1. Owner and Engineer shall not be responsible for the accuracy or completeness of any such information or data provided by others; and

2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:
   a. reviewing and checking all such information and data;
   b. locating all Underground Facilities shown or indicated in the Contract Documents;
   c. coordination of the Work with the owners of such Underground Facilities, including Owner, during construction; and
   d. the safety and protection of all such Underground Facilities and repairing any damage thereto resulting from the Work.

B. Not Shown or Indicated:

1. If an Underground Facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated, or not shown or indicated with reasonable accuracy in the Contract Documents, Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer. Engineer will promptly review the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence or location of the Underground Facility. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

2. If Engineer concludes that a change in the Contract Documents is required, a Work Change Directive or a Change Order will be issued to reflect and document such consequences. An equitable adjustment shall be made in the Contract Price or Contract Times, or both, to the extent that they are attributable to the existence or location of any Underground Facility that was not shown or indicated or not shown or indicated with reasonable accuracy in the Contract Documents and that Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment in Contract Price or Contract Times, Owner or Contractor may make a Claim therefor as provided in Paragraph 10.05.
4.05 **Reference Points**

A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer’s judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.06 **Hazardous Environmental Condition at Site**

A. **Reports and Drawings:** The Supplementary Conditions identify those reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at the Site.

B. **Limited Reliance by Contractor on Technical Data Authorized:** Contractor may rely upon the accuracy of the “technical data” contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such “technical data” is identified in the Supplementary Conditions. Except for such reliance on such “technical data,” Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:

1. the completeness of such reports and drawings for Contractor’s purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any “technical data” or any such other data, interpretations, opinions or information.

C. Contractor shall not be responsible for any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work. Contractor shall be responsible for a Hazardous Environmental Condition created with any materials brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible.

D. If Contractor encounters a Hazardous Environmental Condition or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, Contractor shall immediately: (i) secure or otherwise isolate such condition; (ii) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 6.16.A); and (iii) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to
permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 4.06.E.

E. Contractor shall not be required to resume Work in connection with such condition or in any affected area until after Owner has obtained any required permits related thereto and delivered written notice to Contractor: (i) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work; or (ii) specifying any special conditions under which such Work may be resumed safely. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, either party may make a Claim therefor as provided in Paragraph 10.05.

F. If after receipt of such written notice Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of an adjustment in Contract Price or Contract Times as a result of deleting such portion of the Work, then either party may make a Claim therefor as provided in Paragraph 10.05. Owner may have such deleted portion of the Work performed by Owner’s own forces or others in accordance with Article 7.

G. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition: (i) was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be included within the scope of the Work, and (ii) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.G shall obligate Owner to indemnify any individual or entity from and against the consequences of that individual’s or entity’s own negligence.

H. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.H shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual’s or entity’s own negligence.

I. The provisions of Paragraphs 4.02, 4.03, and 4.04 do not apply to a Hazardous Environmental Condition uncovered or revealed at the Site.
ARTICLE 5 – BONDS AND INSURANCE

5.01 Performance, Payment, and Other Bonds

A. Contractor shall furnish performance and payment bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all of Contractor’s obligations under the Contract Documents. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 13.07, whichever is later, except as provided otherwise by Laws or Regulations or by the Contract Documents. Contractor shall also furnish such other bonds as are required by the Contract Documents.

B. All bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the list of “Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies” as published in Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. All bonds signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual’s authority to bind the surety. The evidence of authority shall show that it is effective on the date the agent or attorney-in-fact signed each bond.

C. If the surety on any bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of Paragraph 5.01.B, Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the requirements of Paragraphs 5.01.B and 5.02.

5.02 Licensed Sureties and Insurers

A. All bonds and insurance required by the Contract Documents to be purchased and maintained by Owner or Contractor shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds or insurance policies for the limits and coverages so required. Such surety and insurance companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

5.03 Certificates of Insurance

A. Contractor shall deliver to Owner, with copies to each additional insured and loss payee identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Owner or any other additional insured) which Contractor is required to purchase and maintain.

B. Owner shall deliver to Contractor, with copies to each additional insured and loss payee identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Contractor or any other additional insured) which Owner is required to purchase and maintain.
C. Failure of Owner to demand such certificates or other evidence of Contractor's full compliance with these insurance requirements or failure of Owner to identify a deficiency in compliance from the evidence provided shall not be construed as a waiver of Contractor’s obligation to maintain such insurance.

D. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor.

E. The insurance and insurance limits required herein shall not be deemed as a limitation on Contractor’s liability under the indemnities granted to Owner in the Contract Documents.

5.04 Contractor’s Insurance

A. Contractor shall purchase and maintain such insurance as is appropriate for the Work being performed and as will provide protection from claims set forth below which may arise out of or result from Contractor’s performance of the Work and Contractor’s other obligations under the Contract Documents, whether it is to be performed by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable:

1. claims under workers’ compensation, disability benefits, and other similar employee benefit acts;

2. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor’s employees;

3. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor’s employees;

4. claims for damages insured by reasonably available personal injury liability coverage which are sustained:
   a. by any person as a result of an offense directly or indirectly related to the employment of such person by Contractor, or
   b. by any other person for any other reason;

5. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom; and

6. claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.

B. The policies of insurance required by this Paragraph 5.04 shall:

1. with respect to insurance required by Paragraphs 5.04.A.3 through 5.04.A.6 inclusive, be written on an occurrence basis, include as additional insureds (subject to any customary exclusion regarding professional liability) Owner and Engineer, and any other individuals or entities identified in the Supplementary Conditions, all of whom shall be listed as additional insureds, and include coverage for the respective officers, directors, members, partners,
employees, agents, consultants, and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;

2. include at least the specific coverages and be written for not less than the limits of liability provided in the Supplementary Conditions or required by Laws or Regulations, whichever is greater;

3. include contractual liability insurance covering Contractor’s indemnity obligations under Paragraphs 6.11 and 6.20;

4. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured identified in the Supplementary Conditions to whom a certificate of insurance has been issued (and the certificates of insurance furnished by the Contractor pursuant to Paragraph 5.03 will so provide);

5. remain in effect at least until final payment and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work in accordance with Paragraph 13.07; and

6. include completed operations coverage:
   a. Such insurance shall remain in effect for two years after final payment.
   b. Contractor shall furnish Owner and each other additional insured identified in the Supplementary Conditions, to whom a certificate of insurance has been issued, evidence satisfactory to Owner and any such additional insured of continuation of such insurance at final payment and one year thereafter.

5.05 Owner’s Liability Insurance

A. In addition to the insurance required to be provided by Contractor under Paragraph 5.04, Owner, at Owner’s option, may purchase and maintain at Owner’s expense Owner’s own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.

5.06 Property Insurance

A. Unless otherwise provided in the Supplementary Conditions, Owner shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:

1. include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of
them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee;

2. be written on a Builder’s Risk “all-risk” policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage (other than that caused by flood), and such other perils or causes of loss as may be specifically required by the Supplementary Conditions.

3. include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);

4. cover materials and equipment stored at the Site or at another location that was agreed to in writing by Owner prior to being incorporated in the Work, provided that such materials and equipment have been included in an Application for Payment recommended by Engineer;

5. allow for partial utilization of the Work by Owner;

6. include testing and startup; and

7. be maintained in effect until final payment is made unless otherwise agreed to in writing by Owner, Contractor, and Engineer with 30 days written notice to each other loss payee to whom a certificate of insurance has been issued.

B. Owner shall purchase and maintain such equipment breakdown insurance or additional property insurance as may be required by the Supplementary Conditions or Laws and Regulations which will include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee.

C. All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this Paragraph 5.06 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other loss payee to whom a certificate of insurance has been issued and will contain waiver provisions in accordance with Paragraph 5.07.

D. Owner shall not be responsible for purchasing and maintaining any property insurance specified in this Paragraph 5.06 to protect the interests of Contractor, Subcontractors, or others in the Work to the extent of any deductible amounts that are identified in the Supplementary Conditions. The risk of loss within such identified deductible amount will be borne by Contractor, Subcontractors, or others suffering any such loss, and if any of them wishes property insurance coverage within the limits of such amounts, each may purchase and maintain it at the purchaser’s own expense.
E. If Contractor requests in writing that other special insurance be included in the property insurance policies provided under this Paragraph 5.06, Owner shall, if possible, include such insurance, and the cost thereof will be charged to Contractor by appropriate Change Order. Prior to commencement of the Work at the Site, Owner shall in writing advise Contractor whether or not such other insurance has been procured by Owner.

5.07 Waiver of Rights

A. Owner and Contractor intend that all policies purchased in accordance with Paragraph 5.06 will protect Owner, Contractor, Subcontractors, and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) in such policies and will provide primary coverage for all losses and damages caused by the perils or causes of loss covered thereby. All such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or loss payees thereunder. Owner and Contractor waive all rights against each other and their respective officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them for all losses and damages caused by, arising out of or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Subcontractors and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner as trustee or otherwise payable under any policy so issued.

B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them for:

1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner’s property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner; and

2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial utilization pursuant to Paragraph 14.05, after Substantial Completion pursuant to Paragraph 14.04, or after final payment pursuant to Paragraph 14.07.

C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 5.07.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against Contractor, Subcontractors, or Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them.
5.08 Receipt and Application of Insurance Proceeds

A. Any insured loss under the policies of insurance required by Paragraph 5.06 will be adjusted with Owner and made payable to Owner as fiduciary for the loss payees, as their interests may appear, subject to the requirements of any applicable mortgage clause and of Paragraph 5.08.B. Owner shall deposit in a separate account any money so received and shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the moneys so received applied on account thereof, and the Work and the cost thereof covered by an appropriate Change Order.

B. Owner as fiduciary shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object in writing within 15 days after the occurrence of loss to Owner’s exercise of this power. If such objection be made, Owner as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached, Owner as fiduciary shall adjust and settle the loss with the insurers and, if required in writing by any party in interest, Owner as fiduciary shall give bond for the proper performance of such duties.

5.09 Acceptance of Bonds and Insurance; Option to Replace

A. If either Owner or Contractor has any objection to the coverage afforded by or other provisions of the bonds or insurance required to be purchased and maintained by the other party in accordance with Article 5 on the basis of non-conformance with the Contract Documents, the objecting party shall so notify the other party in writing within 10 days after receipt of the certificates (or other evidence requested) required by Paragraph 2.01.B. Owner and Contractor shall each provide to the other such additional information in respect of insurance provided as the other may reasonably request. If either party does not purchase or maintain all of the bonds and insurance required of such party by the Contract Documents, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage. Without prejudice to any other right or remedy, the other party may elect to obtain equivalent bonds or insurance to protect such other party’s interests at the expense of the party who was required to provide such coverage, and a Change Order shall be issued to adjust the Contract Price accordingly.

5.10 Partial Utilization, Acknowledgment of Property Insurer

A. If Owner finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 14.05, no such use or occupancy shall commence before the insurers providing the property insurance pursuant to Paragraph 5.06 have acknowledged notice thereof and in writing effected any changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by endorsement on the policy or policies, but the property insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy.
ARTICLE 6 – CONTRACTOR’S RESPONSIBILITIES

6.01 Supervision and Superintendence

A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction. Contractor shall not be responsible for the negligence of Owner or Engineer in the design or specification of a specific means, method, technique, sequence, or procedure of construction which is shown or indicated in and expressly required by the Contract Documents.

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

6.02 Labor; Working Hours

A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the Site.

B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours. Contractor will not permit the performance of Work on a Saturday, Sunday, or any legal holiday without Owner’s written consent (which will not be unreasonably withheld) given after prior written notice to Engineer.

6.03 Services, Materials, and Equipment

A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start-up, and completion of the Work. Contractor shall restrict all activities related to the performance of the Work to the area indicated on the project drawings.

B. All materials and equipment incorporated into the Work shall be as specified or, if not specified, shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

C. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.
6.04  **Progress Schedule**

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.07 as it may be adjusted from time to time as provided below.

1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.07) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times. Such adjustments will comply with any provisions of the General Requirements applicable thereto.

2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 12. Adjustments in Contract Times may only be made by a Change Order.

6.05  **Substitutes and “Or-Equals”**

A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or “or-equal” item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be submitted to Engineer for review under the circumstances described below.

1. **“Or-Equal” Items:** If in Engineer’s sole discretion an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by Engineer as an “or-equal” item, in which case review and approval of the proposed item may, in Engineer’s sole discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items. For the purposes of this Paragraph 6.05.A.1, a proposed item of material or equipment will be considered functionally equal to an item so named if:

   a. in the exercise of reasonable judgment Engineer determines that:

      1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

      2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole; and

      3) it has a proven record of performance and availability of responsive service.

   b. Contractor certifies that, if approved and incorporated into the Work:

      1) there will be no increase in cost to the Owner or increase in Contract Times; and

      2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.
2. **Substitute Items:**

   a. If in Engineer’s sole discretion an item of material or equipment proposed by Contractor does not qualify as an “or-equal” item under Paragraph 6.05.A.1, it will be considered a proposed substitute item.

   b. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefor. Requests for review of proposed substitute items of material or equipment will not be accepted by Engineer from anyone other than Contractor.

   c. The requirements for review by Engineer will be as set forth in Paragraph 6.05.A.2.d, as supplemented by the General Requirements, and as Engineer may decide is appropriate under the circumstances.

   d. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:

      1) shall certify that the proposed substitute item will:

         a) perform adequately the functions and achieve the results called for by the general design,

         b) be similar in substance to that specified, and

         c) be suited to the same use as that specified;

      2) will state:

         a) the extent, if any, to which the use of the proposed substitute item will prejudice Contractor’s achievement of Substantial Completion on time,

         b) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item, and

         c) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty;

      3) will identify:

         a) all variations of the proposed substitute item from that specified, and

         b) available engineering, sales, maintenance, repair, and replacement services; and

      4) shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change.
B. Substitute Construction Methods or Procedures: If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by Engineer. Contractor shall submit sufficient information to allow Engineer, in Engineer’s sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The requirements for review by Engineer will be similar to those provided in Paragraph 6.05.A.2.

C. Engineer’s Evaluation: Engineer will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraphs 6.05.A and 6.05.B. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No “or equal” or substitute will be ordered, installed or utilized until Engineer’s review is complete, which will be evidenced by a Change Order in the case of a substitute and an approved Shop Drawing for an “or equal.” Engineer will advise Contractor in writing of any negative determination.

D. Special Guarantee: Owner may require Contractor to furnish at Contractor’s expense a special performance guarantee or other surety with respect to any substitute.

E. Engineer’s Cost Reimbursement: Engineer will record Engineer’s costs in evaluating a substitute proposed or submitted by Contractor pursuant to Paragraphs 6.05.A.2 and 6.05.B. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

F. Contractor’s Expense: Contractor shall provide all data in support of any proposed substitute or “or-equal” at Contractor’s expense.

6.06 Concerning Subcontractors, Suppliers, and Others

A. Contractor shall not employ any Subcontractor, Supplier, or other individual or entity (including those acceptable to Owner as indicated in Paragraph 6.06.B), whether initially or as a replacement, against whom Owner may have reasonable objection. Contractor shall not be required to employ any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against whom Contractor has reasonable objection.

B. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, or other individuals or entities to be submitted to Owner in advance for acceptance by Owner by a specified date prior to the Effective Date of the Agreement, and if Contractor has submitted a list thereof in accordance with the Supplementary Conditions, Owner’s acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the Bidding Documents or the Contract Documents) of any such Subcontractor, Supplier, or other individual or entity so identified may be revoked on the basis of reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity, and the Contract Price will be adjusted by the difference in the cost occasioned by such replacement, and an appropriate Change Order will be issued. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or
entity, whether initially or as a replacement, shall constitute a waiver of any right of Owner or Engineer to reject defective Work.

C. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor’s own acts and omissions. Nothing in the Contract Documents:

1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier or other individual or entity; nor

2. shall create any obligation on the part of Owner or Engineer to pay or to see to the payment of any moneys due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.

D. Contractor shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work under a direct or indirect contract with Contractor.

E. Contractor shall require all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work to communicate with Engineer through Contractor.

F. The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

G. All Work performed for Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between Contractor and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer. Whenever any such agreement is with a Subcontractor or Supplier who is listed as a loss payee on the property insurance provided in Paragraph 5.06, the agreement between the Contractor and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against Owner, Contractor, Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insurers or loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, Contractor will obtain the same.

6.07 Patent Fees and Royalties

A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its
use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.

B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.

C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

6.08 Permits

A. Unless otherwise provided in the Supplementary Conditions, Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement. Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

6.09 Laws and Regulations

A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Engineer shall be responsible for monitoring Contractor’s compliance with any Laws or Regulations.

B. If Contractor performs any Work knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work. However, it shall not be Contractor’s responsibility to make certain that the Specifications and Drawings are in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor’s obligations under Paragraph 3.03.

C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids) having an effect on the cost or time of performance of the Work shall be the subject of an adjustment in Contract Price or Contract Times. If Owner
and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

6.10 Taxes

A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

6.11 Use of Site and Other Areas

A. Limitation on Use of Site and Other Areas:

1. Contractor shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site and other areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and other areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof, or of any adjacent land or areas resulting from the performance of the Work.

2. Should any claim be made by any such owner or occupant because of the performance of the Work, Contractor shall promptly settle with such other party by negotiation or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law.

3. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused by or based upon Contractor’s performance of the Work.

B. Removal of Debris During Performance of the Work: During the progress of the Work Contractor shall keep the Site and other areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.

C. Cleaning: Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

D. Loading Structures: Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.
6.12 *Record Documents*

A. Contractor shall maintain in a safe place at the Site one record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, and written interpretations and clarifications in good order and annotated to show changes made during construction. These record documents together with all approved Samples and a counterpart of all approved Shop Drawings will be available to Engineer for reference. Upon completion of the Work, these record documents, Samples, and Shop Drawings will be delivered to Engineer for Owner.

6.13 *Safety and Protection*

A. Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

1. all persons on the Site or who may be affected by the Work;
2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify owners of adjacent property and of Underground Facilities and other utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.

C. Contractor shall comply with the applicable requirements of Owner’s safety programs, if any. The Supplementary Conditions identify any Owner’s safety programs that are applicable to the Work.

D. Contractor shall inform Owner and Engineer of the specific requirements of Contractor’s safety program with which Owner’s and Engineer’s employees and representatives must comply while at the Site.

E. All damage, injury, or loss to any property referred to in Paragraph 6.13.A.2 or 6.13.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts
any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

F. Contractor’s duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 14.07.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

6.14 Safety Representative

A. Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

6.15 Hazard Communication Programs

A. Contractor shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

6.16 Emergencies

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent threatened damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby or are required as a result thereof. If Engineer determines that a change in the Contract Documents is required because of the action taken by Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

6.17 Shop Drawings and Samples

A. Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals (as required by Paragraph 2.07). Each submittal will be identified as Engineer may require.

1. Shop Drawings:
   a. Submit number of copies specified in the General Requirements.
   b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 6.17.D.

2. Samples:
   a. Submit number of Samples specified in the Specifications.
b. Clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 6.17.D.

B. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer’s review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. **Submittal Procedures:**

1. Before submitting each Shop Drawing or Sample, Contractor shall have:
   
   a. reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;
   
   b. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;
   
   c. determined and verified the suitability of all materials offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
   
   d. determined and verified all information relative to Contractor’s responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

2. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor’s obligations under the Contract Documents with respect to Contractor’s review and approval of that submittal.

3. With each submittal, Contractor shall give Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be both a written communication separate from the Shop Drawings or Sample submittal; and, in addition, by a specific notation made on each Shop Drawing or Sample submitted to Engineer for review and approval of each such variation.

D. **Engineer’s Review:**

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer’s review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.

2. Engineer’s review and approval will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular means, method, technique, sequence, or procedure of construction is specifically and expressly called for by the
Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

3. Engineer’s review and approval shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 6.17.C.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer’s review and approval shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 6.17.C.1.

E. Resubmittal Procedures:

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous submittals.

6.18 Continuing the Work

A. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraph 15.04 or as Owner and Contractor may otherwise agree in writing.

6.19 Contractor’s General Warranty and Guarantee

A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its officers, directors, members, partners, employees, agents, consultants, and subcontractors shall be entitled to rely on representation of Contractor’s warranty and guarantee.

B. Contractor’s warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or

2. normal wear and tear under normal usage.

C. Contractor’s obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor’s obligation to perform the Work in accordance with the Contract Documents:

1. observations by Engineer;

2. recommendation by Engineer or payment by Owner of any progress or final payment;
3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;

4. use or occupancy of the Work or any part thereof by Owner;

5. any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice of acceptability by Engineer;

6. any inspection, test, or approval by others; or

7. any correction of defective Work by Owner.

6.20 Indemnification

A. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable.

B. In any and all claims against Owner or Engineer or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.20.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers’ compensation acts, disability benefit acts, or other employee benefit acts.

C. The indemnification obligations of Contractor under Paragraph 6.20.A shall not extend to the liability of Engineer and Engineer’s officers, directors, members, partners, employees, agents, consultants and subcontractors arising out of:

1. the preparation or approval of, or the failure to prepare or approve maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or

2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.
6.21 **Delegation of Professional Design Services**

A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor’s responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable law.

B. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional’s written approval when submitted to Engineer.

C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.

D. Pursuant to this Paragraph 6.21, Engineer’s review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer’s review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 6.17.D.1.

E. Contractor shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

**ARTICLE 7 – OTHER WORK AT THE SITE**

7.01 **Related Work at Site**

A. Owner may perform other work related to the Project at the Site with Owner’s employees, or through other direct contracts therefor, or have other work performed by utility owners. If such other work is not noted in the Contract Documents, then:

1. written notice thereof will be given to Contractor prior to starting any such other work; and

2. if Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times that should be allowed as a result of such other work, a Claim may be made therefor as provided in Paragraph 10.05.

B. Contractor shall afford each other contractor who is a party to such a direct contract, each utility owner, and Owner, if Owner is performing other work with Owner’s employees, proper and safe
access to the Site, provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and properly coordinate the Work with theirs. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected. The duties and responsibilities of Contractor under this Paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of Contractor in said direct contracts between Owner and such utility owners and other contractors.

C. If the proper execution or results of any part of Contractor’s Work depends upon work performed by others under this Article 7, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor’s Work. Contractor’s failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor’s Work except for latent defects and deficiencies in such other work.

7.02 Coordination

A. If Owner intends to contract with others for the performance of other work on the Project at the Site, the following will be set forth in Supplementary Conditions:

1. the individual or entity who will have authority and responsibility for coordination of the activities among the various contractors will be identified;

2. the specific matters to be covered by such authority and responsibility will be itemized; and

3. the extent of such authority and responsibilities will be provided.

B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

7.03 Legal Relationships

A. Paragraphs 7.01.A and 7.02 are not applicable for utilities not under the control of Owner.

B. Each other direct contract of Owner under Paragraph 7.01.A shall provide that the other contractor is liable to Owner and Contractor for the reasonable direct delay and disruption costs incurred by Contractor as a result of the other contractor’s wrongful actions or inactions.

C. Contractor shall be liable to Owner and any other contractor under direct contract to Owner for the reasonable direct delay and disruption costs incurred by such other contractor as a result of Contractor’s wrongful action or inactions.
ARTICLE 8 – OWNER’S RESPONSIBILITIES

8.01 Communications to Contractor

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

8.02 Replacement of Engineer

A. In case of termination of the employment of Engineer, Owner shall appoint an engineer to whom Contractor makes no reasonable objection, whose status under the Contract Documents shall be that of the former Engineer.

8.03 Furnish Data

A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

8.04 Pay When Due

A. Owner shall make payments to Contractor when they are due as provided in Paragraphs 14.02.C and 14.07.C.

8.05 Lands and Easements; Reports and Tests

A. Owner’s duties with respect to providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. Paragraph 4.02 refers to Owner’s identifying and making available to Contractor copies of reports of explorations and tests of subsurface conditions and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

8.06 Insurance

A. Owner’s responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 5.

8.07 Change Orders

A. Owner is obligated to execute Change Orders as indicated in Paragraph 10.03.

8.08 Inspections, Tests, and Approvals

A. Owner’s responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 13.03.B.

8.09 Limitations on Owner’s Responsibilities

A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor’s means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws
and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor’s failure to perform the Work in accordance with the Contract Documents.

8.10 Undisclosed Hazardous Environmental Condition

A. Owner’s responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 4.06.

8.11 Evidence of Financial Arrangements

A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner’s obligations under the Contract Documents.

8.12 Compliance with Safety Program

A. While at the Site, Owner’s employees and representatives shall comply with the specific applicable requirements of Contractor’s safety programs of which Owner has been informed pursuant to Paragraph 6.13.D.

ARTICLE 9 – ENGINEER’S STATUS DURING CONSTRUCTION

9.01 Owner’s Representative

A. Engineer will be Owner’s representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner’s representative during construction are set forth in the Contract Documents.

9.02 Visits to Site

A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor’s executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer’s efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

B. Engineer’s visits and observations are subject to all the limitations on Engineer’s authority and responsibility set forth in Paragraph 9.09. Particularly, but without limitation, during or as a result of Engineer’s visits or observations of Contractor’s Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor’s means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.
9.03  *Project Representative*

A. If Owner and Engineer agree, Engineer will furnish a Resident Project Representative to assist Engineer in providing more extensive observation of the Work. The authority and responsibilities of any such Resident Project Representative and assistants will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph 9.09. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer’s consultant, agent or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

9.04  *Authorized Variations in Work*

A. Engineer may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. These may be accomplished by a Field Order and will be binding on Owner and also on Contractor, who shall perform the Work involved promptly. If Owner or Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, and the parties are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

9.05  *Rejecting Defective Work*

A. Engineer will have authority to reject Work which Engineer believes to be defective, or that Engineer believes will not produce a completed Project that conforms to the Contract Documents or that will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Engineer will also have authority to require special inspection or testing of the Work as provided in Paragraph 13.04, whether or not the Work is fabricated, installed, or completed.

9.06  *Shop Drawings, Change Orders and Payments*

A. In connection with Engineer’s authority, and limitations thereof, as to Shop Drawings and Samples, see Paragraph 6.17.

B. In connection with Engineer’s authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, see Paragraph 6.21.

C. In connection with Engineer’s authority as to Change Orders, see Articles 10, 11, and 12.

D. In connection with Engineer’s authority as to Applications for Payment, see Article 14.

9.07  *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer’s preliminary determinations
on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer’s written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of Paragraph 10.05.

9.08 Decisions on Requirements of Contract Documents and Acceptability of Work

A. Engineer will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. All matters in question and other matters between Owner and Contractor arising prior to the date final payment is due relating to the acceptability of the Work, and the interpretation of the requirements of the Contract Documents pertaining to the performance of the Work, will be referred initially to Engineer in writing within 30 days of the event giving rise to the question.

B. Engineer will, with reasonable promptness, render a written decision on the issue referred. If Owner or Contractor believes that any such decision entitles them to an adjustment in the Contract Price or Contract Times or both, a Claim may be made under Paragraph 10.05. The date of Engineer’s decision shall be the date of the event giving rise to the issues referenced for the purposes of Paragraph 10.05.B.

C. Engineer’s written decision on the issue referred will be final and binding on Owner and Contractor, subject to the provisions of Paragraph 10.05.

D. When functioning as interpreter and judge under this Paragraph 9.08, Engineer will not show partiality to Owner or Contractor and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

9.09 Limitations on Engineer’s Authority and Responsibilities

A. Neither Engineer’s authority or responsibility under this Article 9 or under any other provision of the Contract Documents nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor’s means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor’s failure to perform the Work in accordance with the Contract Documents.

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer’s review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 14.07.A will only be to determine generally that their content complies with the requirements of,
and in the case of certificates of inspections, tests, and approvals that the results certified indicate compliance with, the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 9.09 shall also apply to the Resident Project Representative, if any, and assistants, if any.

9.10 Compliance with Safety Program

A. While at the Site, Engineer’s employees and representatives shall comply with the specific applicable requirements of Contractor’s safety programs of which Engineer has been informed pursuant to Paragraph 6.13.D.

ARTICLE 10 – CHANGES IN THE WORK; CLAIMS

10.01 Authorized Changes in the Work

A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work by a Change Order, or a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).

B. If Owner and Contractor are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change Directive, a Claim may be made therefor as provided in Paragraph 10.05.

10.02 Unauthorized Changes in the Work

A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents as amended, modified, or supplemented as provided in Paragraph 3.04, except in the case of an emergency as provided in Paragraph 6.16 or in the case of uncovering Work as provided in Paragraph 13.04.D.

10.03 Execution of Change Orders

A. Owner and Contractor shall execute appropriate Change Orders recommended by Engineer covering:

1. changes in the Work which are: (i) ordered by Owner pursuant to Paragraph 10.01.A, (ii) required because of acceptance of defective Work under Paragraph 13.08.A or Owner’s correction of defective Work under Paragraph 13.09, or (iii) agreed to by the parties;

2. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive; and

3. changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by Engineer pursuant to Paragraph 10.05; provided that, in lieu of
executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, Contractor shall carry on the Work and adhere to the Progress Schedule as provided in Paragraph 6.18.A.

10.04 Notification to Surety

A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor’s responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

10.05 Claims

A. Engineer’s Decision Required: All Claims, except those waived pursuant to Paragraph 14.09, shall be referred to the Engineer for decision. A decision by Engineer shall be required as a condition precedent to any exercise by Owner or Contractor of any rights or remedies either may otherwise have under the Contract Documents or by Laws and Regulations in respect of such Claims.

B. Notice: Written notice stating the general nature of each Claim shall be delivered by the claimant to Engineer and the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto. The responsibility to substantiate a Claim shall rest with the party making the Claim. Notice of the amount or extent of the Claim, with supporting data shall be delivered to the Engineer and the other party to the Contract within 60 days after the start of such event (unless Engineer allows additional time for claimant to submit additional or more accurate data in support of such Claim). A Claim for an adjustment in Contract Price shall be prepared in accordance with the provisions of Paragraph 12.01.B. A Claim for an adjustment in Contract Times shall be prepared in accordance with the provisions of Paragraph 12.02.B. Each Claim shall be accompanied by claimant’s written statement that the adjustment claimed is the entire adjustment to which the claimant believes it is entitled as a result of said event. The opposing party shall submit any response to Engineer and the claimant within 30 days after receipt of the claimant’s last submittal (unless Engineer allows additional time).

C. Engineer’s Action: Engineer will review each Claim and, within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any, take one of the following actions in writing:

1. deny the Claim in whole or in part;

2. approve the Claim; or

3. notify the parties that the Engineer is unable to resolve the Claim if, in the Engineer’s sole discretion, it would be inappropriate for the Engineer to do so. For purposes of further resolution of the Claim, such notice shall be deemed a denial.

D. In the event that Engineer does not take action on a Claim within said 30 days, the Claim shall be deemed denied.
E. Engineer’s written action under Paragraph 10.05.C or denial pursuant to Paragraphs 10.05.C.3 or 10.05.D will be final and binding upon Owner and Contractor, unless Owner or Contractor invoke the dispute resolution procedure set forth in Article 16 within 30 days of such action or denial.

F. No Claim for an adjustment in Contract Price or Contract Times will be valid if not submitted in accordance with this Paragraph 10.05.

ARTICLE 11 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

11.01 Cost of the Work

A. Costs Included: The term Cost of the Work means the sum of all costs, except those excluded in Paragraph 11.01.B, necessarily incurred and paid by Contractor in the proper performance of the Work. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, the costs to be reimbursed to Contractor will be only those additional or incremental costs required because of the change in the Work or because of the event giving rise to the Claim. Except as otherwise may be agreed to in writing by Owner, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall not include any of the costs itemized in Paragraph 11.01.B, and shall include only the following items:

1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers’ compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by Owner.

2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers’ field services required in connection therewith. All cash discounts shall accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts shall accrue to Owner. All trade discounts, rebates and refunds and returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.

3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor’s Cost of the Work and fee shall be determined in the same manner as Contractor’s Cost of the Work and fee as provided in this Paragraph 11.01.
4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.

5. Supplemental costs including the following:

   a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor’s employees incurred in discharge of duties connected with the Work.

   b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

   c. Rentals of all construction equipment and machinery, and the parts thereof whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

   d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.

   e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

   f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 5.06.D), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor’s fee.

   g. The cost of utilities, fuel, and sanitary facilities at the Site.

   h. Minor expenses such as telegrams, long distance telephone calls, telephone service at the Site, express and courier services, and similar petty cash items in connection with the Work.

   i. The costs of premiums for all bonds and insurance Contractor is required by the Contract Documents to purchase and maintain.

B. Costs Excluded: The term Cost of the Work shall not include any of the following items:
1. Payroll costs and other compensation of Contractor’s officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor’s principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 11.01.A.1 or specifically covered by Paragraph 11.01.A.4, all of which are to be considered administrative costs covered by the Contractor’s fee.

2. Expenses of Contractor’s principal and branch offices other than Contractor’s office at the Site.

3. Any part of Contractor’s capital expenses, including interest on Contractor’s capital employed for the Work and charges against Contractor for delinquent payments.

4. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraphs 11.01.A.

C. **Contractor’s Fee:** When all the Work is performed on the basis of cost-plus, Contractor’s fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor’s fee shall be determined as set forth in Paragraph 12.01.C.

D. **Documentation:** Whenever the Cost of the Work for any purpose is to be determined pursuant to Paragraphs 11.01.A and 11.01.B, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

### 11.02 Allowances

A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.

B. **Cash Allowances:**

1. Contractor agrees that:

   a. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and

   b. Contractor’s costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in
the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.

C. **Contingency Allowance:**

1. Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

11.03 **Unit Price Work**

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by Contractor will be made by Engineer subject to the provisions of Paragraph 9.07.

C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor’s overhead and profit for each separately identified item.

D. Owner or Contractor may make a Claim for an adjustment in the Contract Price in accordance with Paragraph 10.05 if:

1. the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and

2. there is no corresponding adjustment with respect to any other item of Work; and

3. Contractor believes that Contractor is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price and the parties are unable to agree as to the amount of any such increase or decrease.

**ARTICLE 12 – CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES**

12.01 **Change of Contract Price**

A. The Contract Price may only be changed by a Change Order. Any Claim for an adjustment in the Contract Price shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.
B. The value of any Work covered by a Change Order or of any Claim for an adjustment in the Contract Price will be determined as follows:

1. where the Work involved is covered by unit prices contained in the Contract Documents, by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 11.03); or

2. where the Work involved is not covered by unit prices contained in the Contract Documents, by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 12.01.C.2); or

3. where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under Paragraph 12.01.B.2, on the basis of the Cost of the Work (determined as provided in Paragraph 11.01) plus a Contractor’s fee for overhead and profit (determined as provided in Paragraph 12.01.C).

C. Contractor’s Fee: The Contractor’s fee for overhead and profit shall be determined as follows:

1. a mutually acceptable fixed fee; or

2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:
   a. for costs incurred under Paragraphs 11.01.A.1 and 11.01.A.2, the Contractor’s fee shall be 15 percent;
   b. for costs incurred under Paragraph 11.01.A.3, the Contractor’s fee shall be five percent;
   c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 12.01.C.2.a and 12.01.C.2.b is that the Subcontractor who actually performs the Work, at whatever tier, will be paid a fee of 15 percent of the costs incurred by such Subcontractor under Paragraphs 11.01.A.1 and 11.01.A.2 and that any higher tier Subcontractor and Contractor will each be paid a fee of five percent of the amount paid to the next lower tier Subcontractor;
   d. no fee shall be payable on the basis of costs itemized under Paragraphs 11.01.A.4, 11.01.A.5, and 11.01.B;
   e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor’s fee by an amount equal to five percent of such net decrease; and
   f. when both additions and credits are involved in any one change, the adjustment in Contractor’s fee shall be computed on the basis of the net change in accordance with Paragraphs 12.01.C.2.a through 12.01.C.2.e, inclusive.
12.02 Change of Contract Times

A. The Contract Times may only be changed by a Change Order. Any Claim for an adjustment in the Contract Times shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

B. Any adjustment of the Contract Times covered by a Change Order or any Claim for an adjustment in the Contract Times will be determined in accordance with the provisions of this Article 12.

12.03 Delays

A. Where Contractor is prevented from completing any part of the Work within the Contract Times due to delay beyond the control of Contractor, the Contract Times will be extended in an amount equal to the time lost due to such delay if a Claim is made therefor as provided in Paragraph 12.02.A. Delays beyond the control of Contractor shall include, but not be limited to, acts or neglect by Owner, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions, or acts of God.

B. If Owner, Engineer, or other contractors or utility owners performing other work for Owner as contemplated by Article 7, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor’s entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor’s ability to complete the Work within the Contract Times.

C. If Contractor is delayed in the performance or progress of the Work by fire, flood, epidemic, abnormal weather conditions, acts of God, acts or failures to act of utility owners not under the control of Owner, or other causes not the fault of and beyond control of Owner and Contractor, then Contractor shall be entitled to an equitable adjustment in Contract Times, if such adjustment is essential to Contractor’s ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor’s sole and exclusive remedy for the delays described in this Paragraph 12.03.C.

D. Owner, Engineer, and their officers, directors, members, partners, employees, agents, consultants, or subcontractors shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

E. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delays within the control of Contractor. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of Contractor.
ARTICLE 13 – TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

13.01 Notice of Defects

A. Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor. Defective Work may be rejected, corrected, or accepted as provided in this Article 13.

13.02 Access to Work

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and governmental agencies with jurisdictional interests will have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor’s safety procedures and programs so that they may comply therewith as applicable.

13.03 Tests and Inspections

A. Contractor shall give Engineer timely notice of readiness of the Work for all required inspections, tests, or approvals and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.

B. Owner shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:

1. for inspections, tests, or approvals covered by Paragraphs 13.03.C and 13.03.D below;

2. that costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.04.B shall be paid as provided in Paragraph 13.04.C; and

3. as otherwise specifically provided in the Contract Documents.

C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

D. Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for Owner’s and Engineer’s acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor’s purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to Owner and Engineer.
E. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation.

F. Uncovering Work as provided in Paragraph 13.03.E shall be at Contractor’s expense unless Contractor has given Engineer timely notice of Contractor’s intention to cover the same and Engineer has not acted with reasonable promptness in response to such notice.

13.04 Uncovering Work

A. If any Work is covered contrary to the written request of Engineer, it must, if requested by Engineer, be uncovered for Engineer’s observation and replaced at Contractor’s expense.

B. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, Contractor, at Engineer’s request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment.

C. If it is found that the uncovered Work is defective, Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05.

D. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, and testing, and of reconstruction. If the parties are unable to agree as to the amount or extent thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

13.05 Owner May Stop the Work

A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work shall not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

13.06 Correction or Removal of Defective Work

A. Promptly after receipt of written notice, Contractor shall correct all defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by Engineer, remove it from the Project and replace it with Work that is not defective. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers,
architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or removal (including but not limited to all costs of repair or replacement of work of others).

B. When correcting defective Work under the terms of this Paragraph 13.06 or Paragraph 13.07, Contractor shall take no action that would void or otherwise impair Owner’s special warranty and guarantee, if any, on said Work.

13.07 Correction Period

A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents) or by any specific provision of the Contract Documents, any Work is found to be defective, or if the repair of any damages to the land or areas made available for Contractor’s use by Owner or permitted by Laws and Regulations as contemplated in Paragraph 6.11.A is found to be defective, Contractor shall promptly, without cost to Owner and in accordance with Owner’s written instructions:

1. repair such defective land or areas; or
2. correct such defective Work; or
3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective and
4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others or other land or areas resulting therefrom.

B. If Contractor does not promptly comply with the terms of Owner’s written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by Contractor.

C. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.

D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 13.07, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

E. Contractor’s obligations under this Paragraph 13.07 are in addition to any other obligation or warranty. The provisions of this Paragraph 13.07 shall not be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.
13.08 Acceptance of Defective Work

A. If, instead of requiring correction or removal and replacement of defective Work, Owner (and, prior to Engineer’s recommendation of final payment, Engineer) prefers to accept it, Owner may do so. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) attributable to Owner’s evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness) and for the diminished value of the Work to the extent not otherwise paid by Contractor pursuant to this sentence. If any such acceptance occurs prior to Engineer’s recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work, and Owner shall be entitled to an appropriate decrease in the Contract Price, reflecting the diminished value of Work so accepted. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05. If the acceptance occurs after such recommendation, an appropriate amount will be paid by Contractor to Owner.

13.09 Owner May Correct Defective Work

A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace rejected Work as required by Engineer in accordance with Paragraph 13.06.A., or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, Owner may, after seven days written notice to Contractor, correct, or remedy any such deficiency.

B. In exercising the rights and remedies under this Paragraph 13.09, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor’s services related thereto, take possession of Contractor’s tools, appliances, construction equipment and machinery at the Site, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner’s representatives, agents and employees, Owner’s other contractors, and Engineer and Engineer’s consultants access to the Site to enable Owner to exercise the rights and remedies under this Paragraph.

C. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 13.09 will be charged against Contractor, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, Owner may make a Claim therefor as provided in Paragraph 10.05. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor’s defective Work.
D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner’s rights and remedies under this Paragraph 13.09.

ARTICLE 14 – PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 Schedule of Values

A. The Schedule of Values established as provided in Paragraph 2.07.A will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed.

14.02 Progress Payments

A. Applications for Payments:

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner’s interest therein, all of which must be satisfactory to Owner.

2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor’s legitimate obligations associated with prior Applications for Payment.

3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

B. Review of Applications:

1. Engineer will, within 10 days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to Owner or return the Application to Contractor indicating in writing Engineer’s reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.

2. Engineer’s recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer’s observations of the executed Work as an experienced and qualified design professional, and on Engineer’s
review of the Application for Payment and the accompanying data and schedules, that to the 
best of Engineer’s knowledge, information and belief:

a. the Work has progressed to the point indicated;

b. the quality of the Work is generally in accordance with the Contract Documents (subject 
to an evaluation of the Work as a functioning whole prior to or upon Substantial 
Completion, the results of any subsequent tests called for in the Contract Documents, a 
final determination of quantities and classifications for Unit Price Work under Paragraph 
9.07, and any other qualifications stated in the recommendation); and

c. the conditions precedent to Contractor’s being entitled to such payment appear to have 
been fulfilled in so far as it is Engineer’s responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have 
represented that:

a. inspections made to check the quality or the quantity of the Work as it has been 
performed have been exhaustive, extended to every aspect of the Work in progress, or 
involved detailed inspections of the Work beyond the responsibilities specifically 
assigned to Engineer in the Contract Documents; or

b. there may not be other matters or issues between the parties that might entitle Contractor 
to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

4. Neither Engineer’s review of Contractor’s Work for the purposes of recommending 
payments nor Engineer’s recommendation of any payment, including final payment, will 
impose responsibility on Engineer:

a. to supervise, direct, or control the Work, or

b. for the means, methods, techniques, sequences, or procedures of construction, or the 
safety precautions and programs incident thereto, or

c. for Contractor’s failure to comply with Laws and Regulations applicable to Contractor’s 
performance of the Work, or

d. to make any examination to ascertain how or for what purposes Contractor has used the 
moneys paid on account of the Contract Price, or

e. to determine that title to any of the Work, materials, or equipment has passed to Owner 
free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer’s 
opinion, it would be incorrect to make the representations to Owner stated in 
Paragraph 14.02.B.2. Engineer may also refuse to recommend any such payment or, because 
of subsequently discovered evidence or the results of subsequent inspections or tests, revise 
or revoke any such payment recommendation previously made, to such extent as may be 
necessary in Engineer’s opinion to protect Owner from loss because:
a. the Work is defective, or completed Work has been damaged, requiring correction or replacement;

b. the Contract Price has been reduced by Change Orders;

c. Owner has been required to correct defective Work or complete Work in accordance with Paragraph 13.09; or

d. Engineer has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.02.A.

C. Payment Becomes Due:

1. Ten days after presentation of the Application for Payment to Owner with Engineer’s recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02.D) become due, and when due will be paid by Owner to Contractor.

D. Reduction in Payment:

1. Owner may refuse to make payment of the full amount recommended by Engineer because:

   a. claims have been made against Owner on account of Contractor’s performance or furnishing of the Work;

   b. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;

   c. there are other items entitling Owner to a set-off against the amount recommended; or

   d. Owner has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.02.B.5.a through 14.02.B.5.c or Paragraph 15.02.A.

2. If Owner refuses to make payment of the full amount recommended by Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor remediess the reasons for such action.

3. Upon a subsequent determination that Owner’s refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 14.02.C.1 and subject to interest as provided in the Agreement.

14.03 Contractor’s Warranty of Title

A. Contractor warrants and guarantees that title to all Work, materials, and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to Owner no later than the time of payment free and clear of all Liens.
14.04 Substantial Completion

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete (except for items specifically listed by Contractor as incomplete) and request that Engineer issue a certificate of Substantial Completion.

B. Promptly after Contractor’s notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.

C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. Owner shall have seven days after receipt of the tentative certificate during which to make written objection to Engineer as to any provisions of the certificate or attached list. If, after considering such objections, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the tentative certificate to Owner, notify Contractor in writing, stating the reasons therefor. If, after consideration of Owner’s objections, Engineer considers the Work substantially complete, Engineer will, within said 14 days, execute and deliver to Owner and Contractor a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as Engineer believes justified after consideration of any objections from Owner.

D. At the time of delivery of the tentative certificate of Substantial Completion, Engineer will deliver to Owner and Contractor a written recommendation as to division of responsibilities pending final payment between Owner and Contractor with respect to security, operation, safety, and protection of the Work, maintenance, heat, utilities, insurance, and warranties and guarantees. Unless Owner and Contractor agree otherwise in writing and so inform Engineer in writing prior to Engineer’s issuing the definitive certificate of Substantial Completion, Engineer’s aforesaid recommendation will be binding on Owner and Contractor until final payment.

E. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the tentative list.

14.05 Partial Utilization

A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor’s performance of the remainder of the Work, subject to the following conditions:
1. Owner at any time may request Contractor in writing to permit Owner to use or occupy any such part of the Work which Owner believes to be ready for its intended use and substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 14.04.A through D for that part of the Work.

2. Contractor at any time may notify Owner and Engineer in writing that Contractor considers any such part of the Work ready for its intended use and substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 5.10 regarding property insurance.

14.06 Final Inspection

A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

14.07 Final Payment

A. Application for Payment:

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, marked-up record documents (as provided in Paragraph 6.12), and other documents, Contractor may make application for final payment following the procedure for progress payments.

2. The final Application for Payment shall be accompanied (except as previously delivered) by:

   a. all documentation called for in the Contract Documents, including but not limited to the evidence of insurance required by Paragraph 5.04.B.6;

   b. consent of the surety, if any, to final payment;

   c. a list of all Claims against Owner that Contractor believes are unsettled; and
d. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of or Liens filed in connection with the Work.

3. In lieu of the releases or waivers of Liens specified in Paragraph 14.07.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (i) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (ii) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien.

B. Engineer’s Review of Application and Acceptance:

1. If, on the basis of Engineer’s observation of the Work during construction and final inspection, and Engineer’s review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor’s other obligations under the Contract Documents have been fulfilled, Engineer will, within ten days after receipt of the final Application for Payment, indicate in writing Engineer’s recommendation of payment and present the Application for Payment to Owner for payment. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable subject to the provisions of Paragraph 14.09. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. Payment Becomes Due:

1. Thirty days after the presentation to Owner of the Application for Payment and accompanying documentation, the amount recommended by Engineer, less any sum Owner is entitled to set off against Engineer’s recommendation, including but not limited to liquidated damages, will become due and will be paid by Owner to Contractor.

14.08 Final Completion Delayed

A. If, through no fault of Contractor, final completion of the Work is significantly delayed, and if Engineer so confirms, Owner shall, upon receipt of Contractor’s final Application for Payment (for Work fully completed and accepted) and recommendation of Engineer, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by Owner for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if bonds have been furnished as required in Paragraph 5.01, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by Contractor to Engineer with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.
14.09 Waiver of Claims

A. The making and acceptance of final payment will constitute:

1. a waiver of all Claims by Owner against Contractor, except Claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 14.06, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from Contractor’s continuing obligations under the Contract Documents; and

2. a waiver of all Claims by Contractor against Owner other than those previously made in accordance with the requirements herein and expressly acknowledged by Owner in writing as still unsettled.

ARTICLE 15 – SUSPENSION OF WORK AND TERMINATION

15.01 Owner May Suspend Work

A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by notice in writing to Contractor and Engineer which will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be granted an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension if Contractor makes a Claim therefor as provided in Paragraph 10.05.

15.02 Owner May Terminate for Cause

A. The occurrence of any one or more of the following events will justify termination for cause:

1. Contractor’s persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule established under Paragraph 2.07 as adjusted from time to time pursuant to Paragraph 6.04);

2. Contractor’s disregard of Laws or Regulations of any public body having jurisdiction;

3. Contractor’s repeated disregard of the authority of Engineer; or


B. If one or more of the events identified in Paragraph 15.02.A occur, Owner may, after giving Contractor (and surety) seven days written notice of its intent to terminate the services of Contractor:

1. exclude Contractor from the Site, and take possession of the Work and of all Contractor’s tools, appliances, construction equipment, and machinery at the Site, and use the same to the full extent they could be used by Contractor (without liability to Contractor for trespass or conversion);
2. incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere; and

3. complete the Work as Owner may deem expedient.

C. If Owner proceeds as provided in Paragraph 15.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Owner arising out of or relating to completing the Work, such excess will be paid to Contractor. If such claims, costs, losses, and damages exceed such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this Paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

D. Notwithstanding Paragraphs 15.02.B and 15.02.C, Contractor’s services will not be terminated if Contractor begins within seven days of receipt of notice of intent to terminate to correct its failure to perform and proceeds diligently to cure such failure within no more than 30 days of receipt of said notice.

E. Where Contractor’s services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue. Any retention or payment of moneys due Contractor by Owner will not release Contractor from liability.

F. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 5.01.A, the termination procedures of that bond shall supersede the provisions of Paragraphs 15.02.B and 15.02.C.

15.03 Owner May Terminate For Convenience

A. Upon seven days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):

1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;

2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;

3. all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other
dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and

4. reasonable expenses directly attributable to termination.

B. Contractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

15.04 Contractor May Stop Work or Terminate

A. If, through no act or fault of Contractor, (i) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (ii) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (iii) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the Contract and recover from Owner payment on the same terms as provided in Paragraph 15.03.

B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this Paragraph 15.04 are not intended to preclude Contractor from making a Claim under Paragraph 10.05 for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor’s stopping the Work as permitted by this Paragraph.

ARTICLE 16 – DISPUTE RESOLUTION

16.01 Methods and Procedures

A. Either Owner or Contractor may request mediation of any Claim submitted to Engineer for a decision under Paragraph 10.05 before such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association and the other party to the Contract. Timely submission of the request shall stay the effect of Paragraph 10.05.E.

B. Owner and Contractor shall participate in the mediation process in good faith. The process shall be concluded within 60 days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.

C. If the Claim is not resolved by mediation, Engineer’s action under Paragraph 10.05.C or a denial pursuant to Paragraphs 10.05.C.3 or 10.05.D shall become final and binding 30 days after termination of the mediation unless, within that time period, Owner or Contractor:

1. elects in writing to invoke any dispute resolution process provided for in the Supplementary Conditions; or
2. agrees with the other party to submit the Claim to another dispute resolution process; or

3. gives written notice to the other party of the intent to submit the Claim to a court of competent jurisdiction.

ARTICLE 17 – MISCELLANEOUS

17.01 Giving Notice

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:

1. delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended; or

2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

17.02 Computation of Times

A. When any period of time is referred to in the Contract Documents by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

17.03 Cumulative Remedies

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract Documents. The provisions of this Paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

17.04 Survival of Obligations

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion, and acceptance of the Work, or termination or completion of the Contract or termination of the services of Contractor.

17.05 Controlling Law

A. This Contract is to be governed by the law of the state in which the Project is located.

17.06 Headings

Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.
SECTION 00 80 00 – SUPPLEMENTARY CONDITIONS

SCOPE. THESE SUPPLEMENTARY CONDITIONS AMEND OR SUPPLEMENT THE GENERAL CONDITIONS AND OTHER PROVISIONS OF THE CONTRACT DOCUMENTS AS INDICATED HEREIN. ALL PROVISIONS WHICH ARE NOT SO AMENDED OR SUPPLEMENTED REMAIN IN FULL FORCE AND EFFECT.

SC-1. DEFINITIONS AND TERMINOLOGY.

SC-1.01. Defined Terms.

A. Delete and replace definitions 9, 15, 17, 22, 23, 29, and 51 in Paragraph 1.01.A of the General Conditions with the following:

9. Change Order—A document which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.

15. Contractor—The individual or entity with whom Owner has entered into Agreement. The terms Contractor and CONTRACTOR are interchangeable and shall have the same meaning in the Contract Documents.

17. Drawings—That part of the Contract Documents prepared or approved by Consulting engineer which graphically shows the scope, extent, and character of the Work to be performed by Contractor. Shop Drawings and other Contractor Submittals are not Drawings as so defined. The terms Drawings and Plans are interchangeable and shall have the same meaning in the Contract Documents.

19. Engineer—The terms Engineer and ENGINEER are interchangeable and shall refer to the Director of Engineering of the Rock River Water Reclamation District.

22. Hazardous Environmental Condition—The presence at the Site of hazardous materials or conditions, including, but not limited to Contaminated Environmental Media, Asbestos, Metal Bearing Protective Coatings, Paints, and Linings, PCBs, Petroleum, Hazardous Waste, Radioactive Materials, metals such as but not limited to arsenic, cadmium, chrome, cobalt, lead, and mercury, and other Hazardous Substances; in such quantities or circumstances that may present a substantial danger to persons or property exposed thereto or cause them to come under the application of a federal, state, or local regulation.


29. Owner—The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed. The terms Owner and OWNER and District are interchangeable and shall have the same meaning in the Contract Documents.

51. Work Change Directive—A written statement to Contractor issued on or after the Effective Date of the Agreement and signed by Owner ordering an addition, deletion, or revision in the Work or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed or to emergencies. A
Work Change Directive will not change the Contract Price or the Contracts Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

B. Add the following definitions to Paragraph 1.01.A of the General Conditions:

52. **Consulting Engineer**—The firm of Systems Design Service Engineering, 3600 East State Street, Suite 215, Rockford, IL 61108 and their duly authorized agents, such agents acting within the scope of the particular duties entrusted to them in each case.

53. **Float**—The amount of time between the early start date and the late start date, or early finish date and late finish date, of any of the activities in the progress schedule.

54. **Proposal**—The terms "Proposal" and "Bid" are interchangeable and shall have the same meaning in the Contract Documents.

55. **Resident Project Representative**—In lieu of the definition set forth in Paragraph 1.01.A.36 of the General Conditions, the Resident Project Representative shall be the authorized representative or Owner, who may be assigned to the site or any part thereof.

56. **without exception**—The term "without exception," when used in the Contract Documents following the name of a Supplier or a proprietary item of equipment, product, or material, shall mean that the sources of the product are limited to the listed Suppliers or products and that no like, equivalent, or "or-equal" item and no substitution will be permitted.

57. **Hazardous Substances**—The term Hazardous Substances shall have the meaning provided in 29 CRF 1910.120 titled "Hazardous Waste Operations and Emergency Response," as amended from time to time.

58. **Metal Bearing Protective Coatings, Paints, and Liners**—Protective coatings, paints, and liners that contain measurable amounts of metals such as but not limited to arsenic, cadmium, chrome, cobalt, lead, or mercury.

59. **Contaminated Environmental Media**—Soil, sediment, ground water, or air contaminated with Hazardous Substances.

SC-2. PRELIMINARY MATTERS.

SC-2.02. Copies of Documents. Delete Paragraph 2.02.A of the General Conditions, and replace it with the following new paragraph:

A. The contractor to whom a contract is awarded will be furnished, free of charge, 3 copies of the Project Manual and 3 sets of the Drawings, together with all Addenda. Additional copies of the Project Manual and Drawings may be obtained from Owner on the following basis:

| Full Set of Drawings and Project Manual | $50.00 |

Not to be used for bidding purposes.
SC-3. CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE.

SC-3.05. Reuse of Documents. Delete Paragraphs 3.05.A of the General Conditions and replace it with the following:

A. Contractor and any Subcontractor or Supplier shall not:

1. Have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Consulting Engineer or its consultants, including electronic media editions; or

2. Reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Consulting Engineer or his consultants and specific written verification or adaption by entity responsibility for those documents.

SC-3.06. Electronic Data. Delete Paragraph 3.06.A of the General Conditions and replace it with the following:

A. Except as permitted in the Submittals Procedures section of Division 1 data furnished by Owner, Engineer, or Consulting Engineer to Contractor, or by Contractor to Owner, Engineer, or Consulting Engineer that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user’s sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.

SC-4. AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS; REFERENCE POINTS.

SC-4.02. Subsurface and Physical Conditions.

A. Reports and Drawings. Delete Paragraph 4.02.A of the General Conditions and replace it with the following:

A. Reports and Drawings:

1. No reports of explorations and tests of subsurface conditions at or contiguous to the Site were performed for this project.

B. Limited Reliance by Contractor on Technical Data Authorized. Delete Paragraph 4.02.B of the General Conditions in its entirety and replace it with the following paragraph:

B. No Reliance by Contractor Authorized. Owner, Consulting Engineer, and Engineer do not warrant the accuracy of the physical conditions information and drawings which are not Contract Documents. Contractor uses such information at Contractor’s sole risk.

It shall be understood that the information provided is not guaranteed by Owner, Consulting Engineer, Engineer to be more than a general indication of the physical conditions likely to be found.
SC-4.04. **Underground Facilities.**

A. Shown or Indicated. Delete Paragraph 4.04.A of the General Conditions in its entirety and replace with the following:

   A. Shown or Indicated: The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the Site is based on information and data furnished to Owner or Consulting Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

   1. Owner and Consulting Engineer shall not be responsible for the accuracy or completeness of any such information or data provided by others; and

   2. The cost of all of the following shall be included in the Contract Price, and Contractor shall have full responsibility for:

      a. reviewing and checking all such information and data:

      b. locating all Underground Facilities shown or indicated in the Contract Documents:

      c. coordination of the Work with the owners of such Underground Facilities, including Owner, during construction: and

      d. the safety and protection of all such Underground Facilities and repairing any damage thereto resulting from the Work.

B. Not Shown or Indicated. Delete Paragraph 4.04.B of the General Conditions in its entirety and replace it with the following:

   B. Not Shown or Indicated:

   1. If an Underground Facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated, or not shown or indicated with reasonable accuracy in the Contract Documents, Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), identify the owner of such Underground Facility and give written notice to that owner and to Owner. Owner will promptly review the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document consequences of the existence or location of the Underground Facility. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

   2. If owner concludes that a change in the Contract Documents is required, a Work Change Directive or a Change Order will be issued to reflect and documents such consequences. An equitable adjustment shall be made in the Contract Price or Contract Times, or both, to the extent that they are attributable to the existence or location of any Underground Facility that was not shown or indicated or not shown or indicated with reasonable accuracy in the Contract Documents and that Contractor did not know of.
an could not reasonably have been expected to be aware of or to have anticipated. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of such adjustment in the Contract Price or Contract Times, Owner or Contractor may make a Claim therefor as provided in Paragraph 10.05.

SC-4.06. Hazardous Environmental Condition at Site.

A. DELETE PARAGRAPH 4.06.A OF THE GENERAL CONDITIONS AND REPLACE WITH THE FOLLOWING PARAGRAPH:

A. No reports or drawings related to Hazardous Environmental Conditions at the Site are known to the Owner.

B. Delete Paragraph 4.06.B of the General Conditions in its entirety.

C. Delete Paragraph 4.06.G and 4.06.H of the General Conditions and replace with the following:

G. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner, Consulting Engineer, Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including, but not limited to, all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.G shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual’s or entity’s own negligence.

D. Renumber Paragraph 4.06.I of the General Conditions as Paragraph 4.06.H.

E. Add the following new Paragraph immediately after Paragraph 4.06.H of the General Conditions as renumbered above:

I. Abatement of Hazardous Environmental Conditions at the Site is covered in the Project Requirements section.

SC-5. BONDS AND INSURANCE. DELETE ARTICLE 5 OF THE GENERAL CONDITIONS IN ITS ENTIRETY, AND INSERT THE FOLLOWING TEXT IN ITS PLACE:

ARTICLE 5 – BONDS AND INSURANCE

Bonds and Insurance requirements shall be as identified in Instructions To Bidders.

SC-6. CONTRACTOR’S RESPONSIBILITIES.

SC-6.02. Labor; Working Hours. Add the following new paragraphs immediately after Paragraph 6.02.B of the General Conditions:

C. No work shall be done between 4:00 PM and 6:30 AM except when power restoration is required or directed by the owner. Any work on outside of working hours or on Owner holidays requires Owner approval at least two (2) business days.
in advance of the proposed extended work hours. However, emergency work may be done without prior permission.

SC-6.06. Concerning Subcontractors, Suppliers, and Others. Delete Paragraph 6.06.B of the General Conditions in its entirety and insert the following two paragraphs in its place:

B. The Bidding Documents or the Contract Documents require the identity of certain Subcontractors, Suppliers, or other individuals or entitled to be submitted to Owner with the Proposal, and if Contractor has submitted a list of thereof in accordance with the Bidding Documents or the Contract Documents, Owner’s acceptance (either in writing or by failing to make written objection there to by the date indicated for acceptance or objection in the Bidding Documents or Contract Documents) of any such Subcontractor, Supplier, or other individual or entity so identified may be revoked on the basis of reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of any right of Owner or Engineer to reject defective Work.

Particular consideration will be given to the qualifications of each Subcontractor proposed on the List of Subcontractors. The use of Subcontractors proposed by Bidder and accepted by Owner prior to the Notice of Award will be required in the performance of the Work unless otherwise permitted or directed by Owner.


C. Contractor shall furnish to Owner at the time of initial submittal, satisfactory evidence that Suppliers of proprietary materials, equipment, devices, or processes to be furnished or used in the performance of the Work do indemnify, keep, and save harmless Contractor from all liabilities, judgments, costs, damages, and expenses which may arise from the use of such proprietary materials, equipment, devices, or processes, furnished to Contractor for incorporation in or use in performance of the Work and their operation by Owner after acceptance of the Work. Such satisfactory evidence shall consist of patent licenses or patent releases covering proprietary materials, equipment, devices, or processes.

SC-6.09. Laws and Regulations. Add the following new paragraphs immediately after Paragraph 6.09.C of the General Conditions:

D. The Contractor shall plan, schedule, and coordinate work in consideration of Owner’s safety requirements, including but not limited to personal protective equipment for arc flash.

E. Additional laws and regulations are included in the Instructions To Bidders.

SC-6.10. Taxes. Add the following new paragraph immediately after Paragraph 6.10.A of the General Conditions:

B. Pursuant to Departments or Revenue, Illinois Retailer’s Occupation Tax Rule 15(4), sales of materials for incorporation into Owner’s real estate are exempt from retailer’s occupation tax and use tax. However, sales of tools, fuel, lumber for forms, and other end use or consumption items which are not incorporated into Owner’s real estate are taxable sales.
SC-6.17. **Shop Drawings and Samples.** Delete Paragraph 6.17 of the General Conditions in its entirety and replace it with the following:

6.17. **Shop Drawings and Samples.** Requirements for shop drawings, samples, and submittal procedures shall be as specified in Section 01 33 00 Submittal Procedures. Fabrication that proceeds prior to acceptance of submittals by Engineer shall be at Contractor’s Risk.


6. an inspection, test, or approval by others;

7. any correction of defective Work by Owner; or

8. any expiration of a correction period.

SC-6.20. **Indemnification.** Delete Paragraph 6.20 of the General Conditions in its entirety and replace it with the following:

6.20. **Indemnification.** Indemnification shall be as indicated in Instructions To Bidders.

SC-6.21. **Delegation of Professional Design Services.**


B. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by an Illinois Licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to Work designed or certified by such professional, if prepared by others, shall bear such professional’s written approval when submitted to Owner.

C. Owner shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications or approval performed by such design professionals, provided Owner has specified to Contractor all performance and design criteria that such services must satisfy.

D. Pursuant to this Paragraph 6.21, Owner’s review and acceptance of signed and sealed certifications of performance and design criteria used when designating systems, materials, or equipment and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Owner’s review and acceptance of Shop Drawings and other submittals (except performance and design criteria and design drawings) will be only for the purpose stated in Division 1 Submittals Procedures section.
SC-8. OWNER’S RESPONSIBILITIES.

SC-8.01. Communications to Contractor. Delete Paragraph 8.01.A of the General Conditions in its entirety, and replace it with the following:

A. Except as otherwise provided in these General Conditions, Owner will issue communications to Contractor.

SC-8.11. Evidence of Financial Arrangements. Delete Paragraph 8.11 of the General Conditions in its entirety, and replace it with the following:


SC-9. ENGINEER’S STATUS DURING CONSTRUCTION.


A. Add the following new words at the end of the first sentence of Paragraph 9.08.A of the General Conditions.

…insofar as the subject matter of any pertinent claim, dispute, or other matter falls within the realm of the technical expertise of Engineer.

B. Add the following new sentence at the end of Paragraph 9.08.A of the General Conditions:

Engineer shall not render any decision on any claims, disputes, or other matters the subject matter of which, at Engineer’s sole discretion, requires legal, rather than technical, interpretation.

C. Delete 9.08.C in its entirety

SC-10. CHANGES IN THE WORK; CLAIMS.

SC-10.03. Execution of Change Orders.

A. Replace the first sentence of Paragraph 10.03.A of the General Conditions with the following:

Owner and Contractor shall execute appropriate Change Orders covering:

B. Delete Paragraph 10.03.A in its entirety.

SC-10.05. Claims.

A. Delete Paragraph 10.05.B of the General Conditions in its entirety, and replace with the following.

B. Notice: Written notice stating the general nature of each Claim shall be delivered by the claimant to Engineer and the other party to the Contract promptly (but in no event later than 7 days) after the start of the event giving rise thereto. The responsibility to substantiate a Claim shall rest with the party making the Claim. Notice of the amount or extent of the Claim, with supporting data shall be delivered to the Engineer and the other party to the Contract within 14 days after the start of such event (unless Engineer allows additional
time for claimant to submit additional or more accurate data in support of such Claim). A claim for an adjustment in Contract Price shall be prepared in accordance with the provisions of Paragraph 12.01.B. A claim for an adjustment in Contract Times shall be prepared in accordance with the provisions of Paragraph 12.02.B. Each Claim shall be accompanied by claimant’s written statement that the adjustment claimed is the entire adjustment to which the claimant believes it is entitled as a result of said event. The opposing party shall submit any response to Engineer and the claimant within 7 days after receipt of the claimant’s last submittal (unless Engineer allows additional time).

B. Delete Paragraph 10.05.E of the General Conditions in its entirety, and replace with the following:

E. Engineer’s written action under Paragraph 10.05.C or denial pursuant to Paragraphs 10.05.C.3 or 10.05.D will be final and binding upon Owner and Contractor, unless Contractor appeals to the Owner’s Board of Trustees within 30 days of such action or denial. All other disputes will be settled by the remedies at law.

SC-11. COST OF THE WORK; ALLOWNACES; UNIT PRICE WORK. – NO MODIFICATIONS.

SC-12. CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES. – NO MODIFICATIONS.

SC-13. TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK.

SC-13.07. Correction Period. Add the following new paragraphs immediately after Paragraph 13.07.E of the General Conditions:

F. Nothing in this Article 13 concerning the correction period shall establish a period of limitation with respect to any other obligation which Contractor has under the Contract Documents. The establishment of time periods relates only to the specific obligations of Contractor to correct the Work, and has no relationship to the time within which Contractor’s obligations under the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish Contractor’s liability with respect to Contractor’s obligations other than to specifically correct the Work.

G. The correct period set forth in Paragraph 13.07.A shall be 2 years in lieu of 1 year. All other provisions of Paragraph 13.07 shall remain unchanged.

SC-14. PAYMENTS TO CONTRACTOR AND COMPLETION.

SC-14.02. Progress Payments. Add the following new paragraphs immediately following Paragraph 14.02.A.3 of the General Conditions:

4. Materials and Equipment. Payments for stored materials and equipment shall be based only upon the actual cost to Contractor of the materials and equipment and shall not include any overhead or profit to Contractor.

Partial Payments will not be made for undelivered materials or equipment.
5. Schedule and Data. During the progress of the Work, each application for Payment shall be accompanied by Contractor's updated schedule of operations or progress report, with such shop drawings schedules, procurement schedules, values of materials and equipment on hand included in application, and other data specified or reasonably required by Engineer.


SC-14.07. Final Payment. Add the following new sentence at the end of Paragraph 14.07.A.2 of the General Conditions:

Consent of the surety, signed by an agent, must be accompanied by a certified copy of such agent's authority to act for the surety.

SC-15. SUSPENSION OF WORK AND TERMINATION. No Modifications.

SC-16. DISPUTE RESOLUTION. Delete Article 16 of the General Conditions in its entirety, and insert the following text in its place:

ARTICLE 16 – NOT USED

SC-17. MISCELLANEOUS. No Modifications.

SC-17.04. Survival of Obligations. Add the following new paragraph immediately after Paragraph 17.04.A of the General Conditions:

B. Contractor shall obtain from all Suppliers and manufacturers any and all warranties and guarantees of such Suppliers and manufacturers, whether or not specifically required by the Specifications, and shall assign such warranties and guarantees to Owner. With respect thereto, Contractor shall render reasonable assistance to Owner when requested, in order to enable Owner to enforce such warranties and guarantees. The assignment of any warranties or guarantees shall not affect the correction period or any other provisions of these Contract Documents.

END OF SECTION 00 08 00
Section IV

Not to be used for bidding purposes